DRAFT

RCRA Facility Investigation – Remedial Investigation/ Corrective Measures Study – Feasibility Study Report for the Rocky Flats Environmental Technology Site Appendix A – Comprehensive Risk Assessment

Volume 11 of 15

Risk Assessment for the Lower Woman Drainage Exposure Unit

This Draft was prepared by Kaiser-Hill Company, L.L.C.
for the U.S. Department of Energy

October 2005

1/294

DEN/E032005011.DOC

TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS ix
EXECUTIVE SUMMARY ES-1
1.0 LOWER WOMAN DRAINAGE EXPOSURE UNIT 1
1.1 Lower Woman Drainage Exposure Unit Description 1
1.1.1 Exposure Unit Characteristics and Location 2
1.1.2 Topography and Surface Water Hydrology 3
1.1.3 Flora and Fauna 3
1.1.4 Preble's Meadow Jumping Mouse Habitat within Lower Woman Drainage Exposure Unit 4
1.1.5 Data Description 6
1.2 Data Adequacy Assessment 9
1.3 Data Quality Assessment 9
2.0 SELECTION OF HUMAN HEALTH CONTAMINANTS OF CONCERN 9
2.1 Contaminant of Concern Selection for Surface Soil/Surface Sediment ... 10
2.1.1 Surface Soil/Surface Sediment Cation/Anion and Essential Nutrient Screen 10
2.1.2 Surface Soil/Surface Sediment Preliminary Remediation Goals Screen 10
2.1.3 Surface Soil/Surface Sediment Detection Frequency Screen 10
2.1.4 Surface Soil/Surface Sediment Background Analysis 10
2.1.5 Surface Soil/Surface Sediment Professional Judgment Evaluation 11
2.2 Contaminant of Concern Selection for Subsurface Soil/Subsurface Sediment 11
2.2.1 Subsurface Soil/Subsurface Sediment Cation/Anion and Essential Nutrient Screen 11
2.2.2 Subsurface Soil/Subsurface Sediment Preliminary Remediation Goal Screen 11
2.2.3 Subsurface Soil/Subsurface Sediment Detection Frequency Screen 12
2.2.4 Subsurface Soil/Subsurface Sediment Background Analysis 12
2.2.5 Subsurface Soil/Subsurface Sediment Professional Judgment Evaluation 12
2.3 Contaminant of Concern Selection Summary 12
3.0 HUMAN HEALTH EXPOSURE ASSESSMENT 12
4.0 HUMAN HEALTH TOXICITY ASSESSMENT 13
5.0 HUMAN HEALTH RISK CHARACTERIZATION 13
6.0 UNCERTAINTIES ASSOCIATED WITH THE HUMAN HEALTH RISK ASSESSMENT 13
6.1 Uncertainties Associated with the Data 13
6.2 Uncertainties Associated with Screening Values 14
6.2.1 Uncertainties Associated with Potential Contaminants of Concern without Preliminary Remediation Goals 14

2

6.3 Uncertainties Associated with Eliminating Potential Contaminants of Concern Based on Professional Judgment ... 14
6.4 Uncertainties Evaluation Summary ... 14
7.0 IDENTIFICATION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN ... 15
7.1 Data Used in the Ecological Risk Assessment ... 15
7.2 Identification of Surface Soil Ecological Contaminants of Potential Concern ... 16
7.2.1 Comparison with No Observed Adverse Effect Level Ecological Screening Levels ... 16
7.2.2 Surface Soil Frequency of Detection Evaluation ... 16
7.2.3 Surface Soil Background Comparisons ... 17
7.2.4 Upper-Bound Exposure Point Concentration Comparisons to Threshold ESLs ... 17
7.2.5 Surface Soil Professional Judgment Evaluation ... 18
7.2.6 Summary of Surface Soil Ecological Contaminants of Potential Concern ... 18
7.3 Identification of Subsurface Soil Ecological Contaminants of Potential Concern ... 19
7.3.1 Comparison to No Observed Adverse Effect Level Ecological Screening Levels ... 19
7.3.2 Subsurface Soil Detection Frequency Evaluation ... 19
7.3.3 Subsurface Soil Background Comparison ... 20
7.3.4 Upper-Bound Exposure Point Concentration Comparisons to Threshold ESLs ... 20
7.3.5 Subsurface Soil Professional Judgment ... 20
7.3.6 Summary of Subsurface Soil Ecological Contaminants of Potential Concern ... 20
7.4 Summary of Ecological Contaminants of Potential Concern ... 21
8.0 ECOLOGICAL EXPOSURE ASSESSMENT ... 21
8.1 Exposure Point Concentrations ... 21
8.2 Receptor-Specific Exposure Parameters ... 22
8.3 Bioaccumulation Factors ... 22
8.4 Intake and Exposure Estimates ... 22
9.0 ECOLOGICAL TOXICITY ASSESSMENT ... 23
10.0 ECOLOGICAL RISK CHARACTERIZATION ... 24
10.1 Chemical Risk Characterization ... 25
10.1.1 Chromium ... 27
10.1.2 Copper ... 29
10.1.3 Manganese ... 31
10.1.4 Nickel ... 32
10.1.5 Selenium ... 35
10.1.6 Thallium ... 36
10.1.7 Tin ... 36
10.1.8 Vanadium ... 38
10.1.9 Zinc ... 40

10.2 Ecosystem Characterization 41
10.3 General Uncertainty Analysis 43
10.3.1 Uncertainties Associated with Data Adequacy and Quality 43
10.3.2 Uncertainties Associated with the Lack of Toxicity Data for Ecological Contaminant of Interest Detected at the Lower Woman Drainage Exposure Unit 43
10.3.3 Uncertainties Associated with Eliminating Ecological Contaminants of Interest Based on Professional Judgment 44
10.4 Summary of Significant Sources of Uncertainty 44
11.0 SUMMARY AND CONCLUSIONS 44
11.1 Human Health 45
11.2 Ecological Risk 45
12.0 REFERENCES 45

LIST OF TABLES

Table 1.1 LWOEU IHSSs

Table 1.2 Number of Samples in Each Medium by Analyte Suite

Table 1.3 Summary of Detected Analytes in Surface Soil/Surface Sediment

Table 1.4 Summary of Detected Analytes in Subsurface Soil/Subsurface Sediment

Table 1.5 Summary of Detected Analytes in Surface Soil

Table 1.6 Summary of Detected Analytes in Surface Soil (PMJM Habitat)

Table 1.7 Summary of Detected Analytes in Subsurface Soil

Table 1.8 Toxicity Equivalence Calculations for Dioxins/Furans – Human Health Receptors

Table 1.9 Toxicity Equivalence Calculations for Dioxins/Furans – Ecological Receptors

Table 2.1 Essential Nutrient Screen for Surface Soil/Surface Sediment

Table 2.2 PRG Screen for Surface Soil/Surface Sediment

Table 2.3 Statistical Distributions and Comparison to Background for LWOEU

Table 2.4 Essential Nutrient Screen for Subsurface Soil/Subsurface Sediment

Table 2.5 PRG Screen for Subsurface Soil/Subsurface Sediment

Table 2.6 Summary of the COC Selection Process

3

Table 6.1 Summary of Detected PCOCs without PRGs in each Medium by Analyte Suite

Table 7.1 Comparison of MDCs in Surface Soil to NOAEL ESLs for Terrestrial Plants, Invertebrates, and Vertebrates in the LWOEU

Table 7.2 Summary of Non-PMJM NOAEL ESL Screening Results for Surface Soil in the LWOEU

Table 7.3 Comparison of MDCs in Surface Soil with NOAEL ESLs for the PMJM in the LWOEU

Table 7.4 Statistical Distribution and Comparison to Background for Surface Soil (Non-PMJM) in the LWOEU

Table 7.5 Statistical Distribution and Comparison to Background for Surface Soil in PMJM Habitat in the LWOEU

Table 7.6 Statistical Concentrations in Surface Soil (Non-PMJM) in the LWOEU

Table 7.7 Upper-Bound Exposure Point Concentration Comparison to Limiting tESLs for Surface Soil (Non-PMJM) in the LWOEU

Table 7.8 Upper-Bound Exposure Point Concentration Comparison to Receptor-Specific ESLs for Small Home-Range Receptors in the LWOEU Surface Soil (Non-PMJM)

Table 7.9 Upper-Bound Exposure Point Concentration Comparison to Receptor-Specific ESLs for Large Home-Range Receptors in the LWOEU Surface Soil (Non-PMJM)

Table 7.10 Summary of ECOPC Screening Steps for Surface Soil Non-PMJM Receptors in the LWOEU

Table 7.11 Summary of ECOPC Screening Steps for Surface Soil PMJM Receptors in the LWOEU

Table 7.12 Comparison of MDCs in Subsurface Soil to NOAEL ESLs for Burrowing Receptors in the LWOEU

Table 7.13 Statistical Distribution and Comparison to Background for Subsurface Soil in the LWOEU

Table 7.14 Statistical Concentrations in Subsurface Soil in the LWOEU

Table 7.15 Upper-Bound Exposure Point Concentration Comparison to tESLs in the LWOEU Subsurface Soil

Table 7.16 Summary of ECOPC Screening Steps for Subsurface Soil in the LWOEU

Table 8.1	Summary of ECOPC/Receptor Pairs
Table 8.2	Surface Soil Exposure Point Concentrations for Non-PMJM Receptors
Table 8.3	Surface Soil Exposure Point Concentrations in PMJM Patches
Table 8.4	Surface Water Exposure Point Concentrations for Non-PMJM and PMJM Receptors
Table 8.5	Receptor-Specific Exposure Parameters
Table 8.6	Receptor-Specific Intake Estimates
Table 8.7	PMJM Intake Estimates
Table 9.1	TRVs for Terrestrial Plant and Invertebrate Receptors
Table 9.2	TRVs for Terrestrial Vertebrate Receptors
Table 10.1	Hazard Quotient Summary for Non-PMJM Receptors
Table 10.2	Hazard Quotient Summary for PMJM Receptors
Table 10.3	Tier 2 Grid Cell Hazard Quotients for Surface Soil in LWOEU
Table 11.1	Summary of Risk Characterization Results for the LWOEU

LIST OF FIGURES

Figure 1.1	Rocky Flats Environmental Technology Site Exposure Units
Figure 1.2	Topography and Historical IHSS Locations in the Lower Woman Drainage Exposure Unit
Figure 1.3	Aerial Photograph of Lower Woman Drainage Exposure Unit, July 2005
Figure 1.4	Vegetation in the Lower Woman Drainage Exposure Unit
Figure 1.5	Preble's Meadow Jumping Mouse Habitat and Surface Soil Sample Locations in the Lower Woman Drainage Exposure Unit
Figure 1.6	Lower Woman Drainage Exposure Unit Surface Soil and Surface Sediment Sample Locations
Figure 1.7	Lower Woman Drainage Exposure Unit Subsurface Soil and Subsurface Sediment Sample Locations
Figure 8.1	Tier 2 EPC 30-Acre Grids with Surface Soil Sample Locations

4

Figure 8.2 Lower Woman Drainage Exposure Unit Surface Soil Sampling Locations in PMJM Habitat for Chromium

Figure 8.3 Lower Woman Drainage Exposure Unit Surface Soil Sampling Locations in PMJM Habitat for Copper

Figure 8.4 Lower Woman Drainage Exposure Unit Surface Soil Sampling Locations in PMJM Habitat for Manganese

Figure 8.5 Lower Woman Drainage Exposure Unit Surface Soil Sampling Locations in PMJM Habitat for Nickel

Figure 8.6 Lower Woman Drainage Exposure Unit Surface Soil Sampling Locations in PMJM Habitat for Selenium

Figure 8.7 Lower Woman Drainage Exposure Unit Surface Soil Sampling Locations in PMJM Habitat for Tin

Figure 8.8 Lower Woman Drainage Exposure Unit Surface Soil Sampling Locations in PMJM Habitat for Vanadium

Figure 8.9 Lower Woman Drainage Exposure Unit Surface Soil Sampling Locations in PMJM Habitat for Zinc

Figure 10.1 Lower Woman Drainage Exposure Unit Sample-by-Sample Comparison to the Limiting ESL – Chromium

Figure 10.2 Lower Woman Drainage Exposure Unit Sample-by-Sample Comparison to the Limiting ESL – Copper

Figure 10.3 Lower Woman Drainage Exposure Unit Sample-by-Sample Comparison to the Limiting ESL – Manganese

Figure 10.4 Lower Woman Drainage Exposure Unit Sample-by-Sample Comparison to the Limiting ESL – Nickel

Figure 10.5 Lower Woman Drainage Exposure Unit Sample-by-Sample Comparison to the Limiting ESL – Thallium

Figure 10.6 Lower Woman Drainage Exposure Unit Sample-by-Sample Comparison to the Limiting ESL – Tin

Figure 10.7 Lower Woman Drainage Exposure Unit Sample-by-Sample Comparison to the Limiting ESL – Vanadium

LIST OF ATTACHMENTS

Attachment 1 Detection Limit Screen

Attachment 2 Data Quality Assessment

Attachment 3 Statistical Analyses and Professional Judgment

Attachment 4 Risk Assessment Calculations

Attachment 5 Chemical-Specific Uncertainty Analysis

Attachment 6 CRA Analytical Data Set

5

ACRONYMS AND ABBREVIATIONS

μg/kg	microgram per kilogram
AEU	Aquatic Exposure Unit
AI	adequate intakes
BAF	bioaccumulation factor
bgs	below ground surface
BZ	Buffer Zone
CAD/ROD	Corrective Action Decision/Record of Decision
CD	compact disc
CDF	polychlorinated dibenzofuran
CDPHE	Colorado Department of Public Health and Environment
CMS	Corrective Measures Study
COC	contaminant of concern
CRA	Comprehensive Risk Assessment
DOE	U.S. Department of Energy
DQA	data quality assessment
DQO	data quality objective
DRI	dietary reference intake
ECOI	ecological contaminant of interest
EcoSSL	ecological soil screening level
ECOPC	ecological contaminant of potential concern
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
ERA	Ecological Risk Assessment

ESL	ecological screening level
EU	Exposure Unit
HHRA	Human Health Risk Assessment
HRR	Historical Release Report
HQ	hazard quotient
IA	Industrial Area
IAG	Interagency Agreement
IHSS	Individual Hazardous Substance Site
LOAEL	lowest observed adverse effect level
LOEC	lowest effects concentration
LWOEU	Lower Woman Drainage Exposure Unit
MDC	maximum detected concentration
mg	milligram
mg/day	milligram per day
mg/kg	milligram per kilogram
mg/kg/BW/day	milligram per kilogram per receptor body weight per day
N/A	not applicable or not available
NFA	No Further Action
NFAA	No Further Accelerated Action
NOAEL	no observed adverse effect level
NOEC	no observed effect concentration
OU	Operable Unit
PAC	Potential Area of Concern
PARCC	precision, accuracy, representativeness, completeness, and comparability
PCOC	potential contaminant of concern

6

PMJM	Preble's meadow jumping mouse
PRG	preliminary remediation goal
QA/QC	quality assurance/quality control
QAPjP	Quality Assurance Project Plan
RCRA	Resource Conservation and Recovery Act
RDA	recommended daily allowance
RDI	recommended daily intake
RFCA	Rocky Flats Cleanup Agreement
RFETS	Rocky Flats Environmental Technology Site
RI/FS	Remedial Investigation/Feasibility Study
SAP	Sampling and Analysis Plan
SCM	Site Conceptual Model
SEEU	Southeast Buffer Zone Area Exposure Unit
SID	South Interceptor Ditch
TCDD	tetrachlorodibenzo-p-dioxin
TEF	toxicity equivalency factor
TEQ	toxic equivalency
tESL	threshold ecological screening level
TRV	toxicity reference value
UBC	Under Building Contamination
UCL	upper confidence limit
UL	upper limit daily intake
UT	uncertain toxicity
UWOEU	Upper Woman Drainage Exposure Unit
UTL	upper tolerance limit

VOC	volatile organic compound
WBEU	Wind Blown Area Exposure Unit
WRS	Wilcoxon Rank Sum
WRV	wildlife refuge visitor
WRW	wildlife refuge worker

EXECUTIVE SUMMARY

This report presents the Human Health Risk Assessment (HHRA) and Ecological Risk Assessment (ERA) for the 448-acre Lower Woman Drainage Exposure Unit (EU) (LWOEU) at the Rocky Flats Environmental Technology Site (RFETS). The purpose of this report is to assess potential risks to human health and ecological receptors posed by exposure to contaminants of concern (COCs) and ecological contaminants of potential concern (ECOPCs) remaining at the LWOEU after completion of accelerated actions at RFETS.

Results of the COC selection process for the HHRA indicate that no COCs were selected and there are no significant human health risks from RFETS-related operations at the LWOEU. As a result, potential health risks for the wildlife refuge worker (WRW) and wildlife refuge visitor (WRV) are expected to be within the range of background risks. The estimated cancer risks for both the WRW and WRV associated with potential exposure to background levels of naturally occurring metals in surface soil/surface sediment are approximately 2E-06. The estimated noncancer hazard indices associated with potential exposure to background levels of metals in surface soil/surface sediment are approximately 0.3 for the WRW and 0.1 for the WRV.

ECOPCs in surface soil were identified for non-Preble's Meadow jumping mouse (PMJM) and PMJM receptors. ECOPCs for selected populations of non- PMJM receptors included chromium, copper, manganese, nickel, thallium, tin, and vanadium. ECOPCs for individual PMJM receptors included chromium, copper, manganese, nickel, selenium, tin, vanadium, and zinc. No ECOPCs were identified in subsurface soil. The ECOPC/receptor pairs were evaluated in the risk characterization using a range of exposure point concentration (EPC), exposure scenarios, and toxicity reference values to give a range of risk estimates. Overall, no significant risks to survival, growth, and reproduction are predicted for the ecological receptors evaluated in the LWOEU.

In addition, the high species diversity and continued use of the site by numerous vertebrate species verify that habitat quality for these species remains acceptable and the ecosystem functions are being maintained (K-H 2000). Data collected on wildlife abundance and diversity indicate that wildlife populations are stable and species richness remains high during remediation activities at RFETS, including wildlife using the LWOEU.

8

1.0 LOWER WOMAN DRAINAGE EXPOSURE UNIT

This volume of the Comprehensive Risk Assessment (CRA) presents the Human Health Risk Assessment (HHRA) and Ecological Risk Assessment (ERA) for the Lower Woman Drainage Exposure Unit (EU) (LWOEU) at the Rocky Flats Environmental Technology Site (RFETS) (Figure 1.1).

The HHRA and ERA methods and selection of receptors are described in detail in the Final CRA Work Plan and Methodology (DOE 2005a), hereafter referred to as the CRA Methodology. A summary of the risk assessment methods, including updates made in consultation with the regulatory agencies, is included in Appendix A, Volume 2, Section 2.0 of the Resource Conservation and Recovery Act (RCRA) Facility Investigation-Remedial Investigation/Corrective Measures Study (CMS)-Feasibility Study (RI/FS) Report (hereafter referred to as the RI/FS Report). The anticipated future land use of RFETS is a wildlife refuge. Two human receptors, a wildlife refuge worker (WRW) and a wildlife refuge visitor (WRV), are evaluated in this risk assessment consistent with this land use. A variety of representative terrestrial and aquatic receptors are evaluated in the ERA including the Preble's meadow jumping mouse (PMJM), a federally listed threatened species present at the RFETS. The HHRA and ERA methods and selection of receptors are described in detail in the CRA Methodology.

1.1 Lower Woman Drainage Exposure Unit Description

This Section provides a brief description of the LWOEU, including its location at RFETS, historical activities in the area, topography, surface water features, vegetation, and ecological resources. A more detailed description of these features and additional information regarding the geology, hydrology, and soil types at RFETS is included in Section 2.0, Physical Characteristics of the Study Area, of the RI/FS Report.

The 2005 Annual update to the Historical Release Report (HRR) (DOE 2005b) and its annual updates provide descriptions of known or suspected releases of hazardous substances that occurred at RFETS. The original HRR (DOE 1992) organized these known or suspected historical sources of contamination as Individual Hazardous Substance Sites (IHSSs), Potential Areas of Concern (PACs), or Under Building Contamination (UBC) areas (hereafter collectively referred to as historical IHSSs). Individual historical IHSSs and groups of historical IHSSs were also designated as Operable Units (OUs). Over the course of cleanup under the 1991 Interagency Agreement (IAG) and the 1996 Rocky Flats Cleanup Agreement (RFCA), the U.S. Department of Energy (DOE) has thoroughly investigated and characterized contamination associated with these historical IHSSs. Historical IHSSs have been dispositioned through appropriate remedial actions or by determining that No Further Accelerated Action (NFAA) is required, pursuant to the applicable IAG and RFCA requirements. Some OUs have also been dispositioned in accordance with an OU-specific Corrective Action Decision/Record of Decision (CAD/ROD).

a

A more detailed description of the regulatory agreements and the investigation and cleanup history under these agreements is contained in Section 1.0 of the RI/FS Report. Section 1.4.3 of the RI/FS Report describes the accelerated action process, and the disposition of all historic IHSSs at RFETS is summarized in Table 1.4 of the RI/FS Report. In the 2005 Annual Update to the HRR (DOE 2005b), each IHSS is provided a description of the potential contaminant releases and any interim response to the releases; identifications of potential contaminants based on process, knowledge, and site data; data collection activities; accelerated action activities (if any); and the basis for recommending no further accelerated action.

Five IHSSs exist within the LWOEU (Table 1.1 and Figure 1.2):

- Roadway Spraying (PAC 000-501);
- East Firing Range (SE-1602);
- Pond C-1 (SE-142.10);
- Pond C-2 (SE-142.11); and
- Surface Disturbance Southeast of Building 881 (SE-209).

PAC 000-501 was one of 79 IHSSs/PACs proposed for No Further Action (NFA) by the NFA Working Group in 1991. The NFA was approved in 2002 (EPA et al. 2002) and is documented in the 2002 HRR Update (DOE 2002). The NFAs for SE-209 and SE-142.10 are documented in the 1997 and 2004 HRRs, respectively. The Closeout Report for IHSS Group 900-11, PAC SE-1602, East Firing Range, and Target Area was approved by the U.S. Environmental Protection Agency (EPA) in a letter from C. Mark Aguilar to Joseph Legare dated February 8, 2005. The Data Summary Report for IHSS Group NE-1, Ponds A-1, A-2, A-3, A-4, A-5, B-4, B-5, and C-2 is in preparation. The NFAs for SE-1602 and SE-142.11 will be documented in the 2005 HRR.

1.1.1 Exposure Unit Characteristics and Location

The LWOEU comprises 448 acres in the southeastern portion of RFETS (Figure 1.1) and contains several distinguishing features:

- The LWOEU is located within the Buffer Zone (BZ) OU and is southeast of the areas that were historically used for operation of RFETS. The LWOEU begins approximately 600 feet upstream of Pond C-1 and extends east to Indiana Street.
- The LWOEU is adjacent to the Wind Blown Area EU (WBEU), which was impacted by airborne migration of radionuclides from the 903 Pad site (IHSS 900-112). This introduced contamination into surface soil in the area. The LWOEU receives runoff from the WBEU.

- The LWOEU receives surface water drainage from the southern edge of the Industrial Area (IA) via the South Interceptor Ditch (SID), which discharges to Pond C-2 (IHSS SE-142.11).

The LWOEU is bounded by the WBEU on the north, the Upper Woman Drainage EU (UWOEU) on the west, the Southeast BZ Area EU (SEEU) to the south, and Indiana Street to the east.

1.1.2 Topography and Surface Water Hydrology

The LWOEU is located in the eastern portion of the Woman Creek Drainage, a major drainage at RFETS that traverses the southern side of the site. The Woman Creek Drainage captures runoff from the southern portion of the IA, as well as the majority of the southern BZ.

The principal surface water features in the LWOEU include the mainstem of Woman Creek, South Woman Creek, and Ponds C-1 and C-2 (Figures 1.2 and 1.3). Upstream of the LWOEU, Woman Creek is largely isolated from IA runoff because the SID, which is located upslope to the north, intercepts surface flow and diverts it into Pond C-2, which is discharged into Woman Creek. Discharge from Pond C-2 has historically been necessary once a year. The annual discharge is monitored for compliance with surface water standards for Segment 4a of Big Dry Creek. In the future, Pond C-2 will be operated on a batch-release mode, and will sustain wetlands and provide for water quality benefit and storm flow storage. Woman Creek flows through Pond C-1, which was reconfigured as a low-profile, flow-through structure in 2005. Discharge from Pond C-1 is diverted around Pond C-2 and back into the Woman Creek Drainage, downgradient from Pond C-2. Downstream of Pond C-2, South Woman Creek joins the mainstem of Woman Creek approximately 0.25 mile upstream from Indiana Street. Portions of the South Woman Creek Drainage that are upgradient of the Smart Ditch diversion, located where South Woman Creek crosses the southern boundary of the LWOEU, do not contribute flow to the LWOEU because Smart Ditch diverts these flows into the next drainage to the south, which contains Ponds D-1 and D-2.

Downstream from Pond C-2, water can be diverted from Woman Creek into Mower Ditch, which is a lateral ditch that traverses the hillside north of Woman Creek and empties into the next drainage basin to the north. Mower Ditch is an agricultural diversion.

1.1.3 Flora and Fauna

Many of the plant communities found at RFETS are present within the LWOEU, as shown on the vegetation map for the LWOEU in Figure 1.4. Mesic-mixed grassland and reclaimed grasslands are the two dominant vegetation communities. Other plant communities comprise annual forb/grass communities and wet meadows. There are three creek drainages that cross this EU: Woman Creek, South Woman Creek, and Mower Ditch. These drainages support drier riparian vegetation including lead plant (*Amorpha fruticosa*). Although found in every drainage on the RFETS, the lead plant dominates the

10

riparian (stream-side) areas in this EU. The existence of the lead plant in the riparian areas results from the drier conditions caused by water diversion practices. Downstream of the Mower Ditch diversion structure, wet meadows and short marshes are present on the hillside between Mower Ditch and Woman Creek. This is likely the result of seepage from Mower Ditch into the hillside below, enabling vegetation that requires more moisture than this hillside normally receives from precipitation.

The mesic-mixed grassland is distinguished at RFETS by such plant species as western wheatgrass (*Agropyron smithii*), blue grama *(Bouteloua gracilis)*, side-oats grama *(Bouteloua curtipendula)*, prairie junegrass *(Koeleria pyramidata)*, Canada bluegrass, Kentucky bluegrass, green needlegrass *(Stipa virigula)*, and little bluestem (*Andropogon scoparius*). Reclaimed grasslands are dominated by two introduced grass species, smooth brome (*Bromus inermis*) and intermediate wheatgrass (*Agropyron intermedium*). Land that is within the LWOEU was heavily grazed during past land use, which has contributed greatly to the expansive areas of annual grasses and forbs. With the purchase of this land by the DOE, grazing has not occurred in decades within the EU, and plant ecologists have partially restored native mesic grasslands in these disturbed areas. Reclaimed grasslands are also the result of past disturbances including DOE's construction of Pond C-2 and agricultural fields that pre-date DOE's ownership.

Numerous animal species have been observed at RFETS, and most of these species are expected to be present in the LWOEU. Common large- and medium-sized mammals likely to live or frequent the LWOEU include mule deer (*Odocoileus hemionus*), white-tailed deer (*Odocoileus virginianus*), coyote (*Canis latrans*), raccoon (*Procyon lotor*), and desert cottontail (*Sylvilagus audubonii*). The most common reptile observed at RFETS is the western prairie rattlesnake (*Crotalis viridus*), and the most common amphibian is the boreal chorus frog (*Pseudacris tryseriatus*). Common birds include red-winged blackbird (*Agelaius phoeniceus*), song sparrow (*Melospiza melodia*), meadow lark (*Sturnella neglecta*), and vesper sparrow (*Pooecetes gramineus*). The most common small mammal species include deer mouse (*Peromyscus maniculatus*), prairie vole (*Microtus ochrogaster*), meadow vole (*Microtus pennsylvanicus*), and different species of harvest mice (*Reithrodontomys sp.*).

More information on plant communities and species that exist within RFETS is provided in Section 2.0 of the RI/FS Report.

1.1.4 Preble's Meadow Jumping Mouse Habitat within Lower Woman Drainage Exposure Unit

LWOEU supports habitat for the federally protected PMJM (*Zapus hudsonius preblei*). The preferred habitat for the PMJM is the riparian corridors bordering RFETS streams, ponds, and wetlands with an adjacent thin band of upland grasslands. Figure 1.5 presents PMJM habitat in this EU. PMJM have been captured within the upper end of the LWOEU (i.e., above Pond C-2) for over a decade (Ebasco 1992; K-H 1997, 1999, 2002). No PMJM have been captured below the C-2 Pond in the EU, although trapping surveys have been conducted (K-H 1997, 2002). As shown in Figure 1.5, the PMJM habitat is subdivided into patches. Sitewide PMJM habitat patches were identified in an effort to characterize habitat discontinuity and provide indications of varying habitat quality. These patches aid in the evaluation of surface soil within PMJM habitat, giving a spatial understanding of areas that may be used by individual PMJM or subpopulations of PMJM. More detail on the methodology of creating sitewide PMJM habitat patches can be found in Appendix A, Volume 2, Section 3.2 of the RI/FS Report.

PMJM habitat within the LWOEU is subdivided into seven habitat patches (Figure 1.5). Risks to the PMJM in these patches are evaluated in Section 7.0 of the LWOEU risk assessment. Each patch contains habitat capable of supporting at least several PMJM individuals; although habitat patches in LWOEU, below Pond C-2, are of lower quality due to the drier conditions in the Lower Woman Creek Drainage. The patches vary in size and shape dependent on their location within the Lower Woman Creek Drainage and the discontinuity or habitat quality of surrounding patches. The following is a brief discussion of the seven patches within LWOEU (Figure 1.5) and the reasons each patch is considered distinct:

- Patch #22A and #22B – This patch is a combination of habitat along the creek corridor (#22A) and an adjacent seep area (#22B). These areas can be considered one unit based on the hydrological connection (supporting wetlands bridge the gap between the two habitat areas). PMJM are present within this patch. The upper boundary of the larger area (#22A) is a dirt road that crosses Woman Creek, and the lower boundary is the C-1 Pond dam face. The boundaries for the smaller area correspond to habitat boundaries mapped earlier by the U.S. Fish and Wildlife Service (USFWS 2004). Patch #22 also includes a Section of habitat (#22A) that extends into the UWOEU.

- Patch #23 – PMJM are present in this patch located between Ponds C-1 and C-2. The patch is thickly wooded immediately below the C-1 Pond and the lower Section is comprised of alternating sections of riparian woodlands and shrublands.

- Patch #24A and #24B – This patch is a combination of two habitat areas along the Lower Woman Creek corridor and the confluence with Mower Ditch. These areas can be considered one unit based on available moisture and plant communities present in this Section of the creek. The upper isolated habitat area (#24A) results from a gap created by rip-rapped sections of the creek and supporting wetlands. This area provides the same habitat quality as the lower area (#24A). The upper boundaries for the lower area correspond to habitat boundaries mapped earlier (USFWS 2004). The lower boundary corresponds to where riparian shrub (lead plant) changes to riparian woodland. Patch #24 also includes a Section of habitat #(24A) that extends into the WBEU, but is evaluated in this EU.

- Patch #25 – This patch contains habitat along Mower Ditch that is disconnected from the upper portion of the ditch by a long Section of dry grasslands. Habitat quality within this patch is very low due to the lack of water most of the year; however, all the vegetative components are present to support PMJM. Patch #25 extends into the WBEU, although it is evaluated in the LWOEU. No PMJM have been found in this patch.

- Patch #26 – This patch begins on Lower Woman Creek where riparian woodlands mix with riparian shrublands. The patch includes the confluence with South Woman Creek upstream to a dirt access road and continues downstream to the RFETS eastern boundary. Patch #26 has more moisture available than upstream patches, possibly from recharged groundwater originating from Mower Ditch. No PMJM have been captured in this patch.

- Patch #27 – This patch includes a long Section of South Woman Creek. The lower boundary corresponds to the dirt service road that crosses the creek, while the upper boundary corresponds to a vegetation change where lead plant is replaced by willow, indicating wetter conditions. No PMJM have been captured in this patch.

- Patch #28 – This patch extends into the SEEU, but is evaluated in this EU. Vegetation within this patch is dominated by riparian woodlands. Downstream, the patch boundary corresponds to a change to drier conditions supporting lead plant. Upstream, the patch boundary is where riparian woodlands give way to continuous riparian willow shrublands. No PMJM have been captured in this patch.

1.1.5 Data Description

Data have been collected at RFETS under regulatory agency-approved Work Plans, Sampling and Analysis Plans (SAPs), and Quality Assurance Project Plans (QAPjPs) to meet data quality objectives (DQOs) and appropriate EPA and Colorado Department of Public Health and Environment (CDPHE) guidance. Surface soil, subsurface soil, surface sediment, subsurface sediment, and groundwater samples were collected from the LWOEU. Surface soil/surface sediment, subsurface soil/subsurface sediment, surface soil, and subsurface soil are the media evaluated in the HHRA and ERA (Table 1.2). The sampling locations for these media are shown in Figures 1.6 and 1.7, and data summaries for detected analytes in each medium are provided in Tables 1.3 through 1.7. Toxicity equivalence (TEQ) concentrations for 2, 3, 7, 8- tetrachlorodibenzo-p-dioxin (TCDD) in surface soil/surface sediment, subsurface soil/subsurface sediment, and subsurface soil are presented in Tables 1.8 and 1.9. The TEQ concentrations for 2,3,7,8-TCDD are derived using toxicity equivalency factors (TEFs) presented in Appendix A, Volume 2 of the RI/FS Report. Potential contaminants of concern (PCOCs) and ecological contaminants of interest (ECOIs) for which analyses were conducted but were not detected, or were detected in less than 5 percent of the samples, are presented in Attachment 1. Detection limits are compared to preliminary remediation goals (PRGs) and ecological screening levels (ESLs) and discussed in Attachment 1 (Tables A1.1 through A1.4). Only data from June 1991 to the present are used in the CRA because these data meet the approved analytical quality assurance/quality control (QA/QC) requirements.

In accordance with the CRA Methodology, only data collected on or after June 28, 1991, and data for subsurface soil and subsurface sediment samples with a starting depth less than or equal to 8 feet below ground surface (bgs), are used in the CRA. Subsurface soil and subsurface sediment data are limited to this depth because it is not anticipated that the WRW or burrowing animals will dig to deeper depths. A detailed description of data storage and processing methods is provided in Appendix A, Volume 2 of the RI/FS Report. The CRA analytical data set for the LWOEU is provided on a compact disc (CD) included in Attachment 6. The CD in Attachment 6 includes the data used in the CRA as well as data not considered useable based on criteria presented in Appendix A, Volume 2 of the RI/FS Report.

The sampling data used for the LWOEU HHRA and ERA are as follows:

- Combined surface soil/surface sediment data (HHRA);
- Combined subsurface soil/subsurface sediment data (HHRA);
- Surface soil data (ERA); and
- Subsurface soil data (ERA).

These data for these media are briefly described below.

In addition, because ECOPCs were identified for soil in this EU, surface water data were used in the ERA as part of the overall intake of ECOPCs by ecological receptor. The surface water data used in the ERA are summarized in Table 8.4. Surface water and sediment are assessed for ecological receptors on an Aquatic Exposure Unit (AEU) basis in Appendix A, Volume 15B of the RI/FS Report. An assessment of the surface water, groundwater-to-surface water, and volatilization pathways for human health are presented in Appendix A, Volume 2 of the RI/FS Report.

Surface Soil/Surface Sediment

The combined surface soil/surface sediment data set for the LWOEU consists of up to 144 samples for various analyte groups. The sediment samples were collected to depths less than 0.5 feet bgs. The surface soil/surface sediment sample locations are shown in Figure 1.6. The surface soil/surface sediment samples were collected in the LWOEU over several months from July 1991 through February 1995, and then again in February 1998, October 2000, March 2001, and over several months in 2004, ending in July 2005. The samples collected in 2004 were located on a 30-acre grid, as described in CRA SAP Addendum #04-01 (DOE 2004). For the grid sampling, five individual samples were collected from each 30-acre cell, one from each quadrant and one in the center, as described in the Addendum. Most of the evenly spaced surface soil sampling locations in Figure 1.6 represent the 30-acre grid samples.

The LWOEU surface soil/surface sediment samples were analyzed for inorganics (106 samples), organics (34 samples), and radionuclides (144 samples) (Table 1.2). Detected analytes included many inorganics and organics (mostly polynuclear aromatic hydrocarbons, but also some solvents, pesticides, and dioxins), and several radionuclides (Table 1.3). The dioxins were present at concentrations less than 1 microgram per kilogram (μg/kg) in the one sample that was collected. A summary of analytes that were

\12

not detected, or were detected in less than 5 percent of the subsurface soil samples, is presented in Attachment 1.

Subsurface Soil/Subsurface Sediment

The combined subsurface soil/subsurface sediment data set for LWOEU consists of up to 55 samples for various analyte groups. The subsurface sediment samples have a starting depth of less than or equal to 8 feet bgs and an ending depth greater than 0.5 feet bgs. The subsurface soil/subsurface sediment sample locations are shown in Figure 1.7. The samples were collected in the LWOEU over several months from October 1991 through August 1994, and then again in July 1999, September 2002, and over several months in 2004, ending in July 2005.

The LWOEU subsurface soil/subsurface sediment samples were analyzed for inorganics (55 samples), organics (36 samples), and radionuclides (31 samples) (Table 1.2). Detected analytes included many inorganics and organics (mostly dioxins but also some solvents), as well as several radionuclides (Table 1.4). The dioxins were present at concentrations less than 1 μg/kg in the three samples that were collected, although most of the dioxins were undetected in two of the samples. A summary of analytes that were not detected, or were detected in less than 5 percent of the subsurface soil samples, is presented in Attachment 1.

Surface Soil

The surface soil data set for LWOEU consists of up to 98 samples for various analyte groups. The samples were collected in the LWOEU over several months from July 1991 through February 1995, and then again in February 1998, March 2001, and over several months in 2004. Sample locations are shown in Figure 1.6. The samples collected in 2004 were located on a 30-acre grid, as described in CRA SAP Addendum #04-01 (DOE 2004). For the grid sampling, five individual samples were collected from each 30-acre cell, one from each quadrant and one in the center, as described in the Addendum. Most of the evenly spaced surface soil sampling locations in Figure 1.6 represent the 30-acre grid samples.

The LWOEU surface soil samples were analyzed for inorganics (74 samples), organics (nine samples), and radionuclides (98 samples) (Table 1.2). Detected analytes included many inorganics, organics, and several radionuclides (Table 1.5). A summary of analytes that were not detected, or were detected in less than 5 percent of the subsurface soil samples, is presented in Attachment 1.

The LWOEU surface soil samples within PMJM habitat were analyzed for inorganics (45 samples), organics (two samples), and radionuclides (41 samples). Detected analytes included many inorganics, one organic (benzoic acid), and several radionuclides (Table 1.6).

Subsurface Soil

The subsurface soil data set for LWOEU consists of up to 47 samples for various analyte groups. The samples were collected in the LWOEU over several months from

October 1991 through August 1994, and then again in July 1999, and over several months in 2004, ending in January 2005. Sample locations are shown in Figure 1.7. Subsurface soil samples to be used in the CRA are defined in the CRA Methodology as soil samples with a starting depth less than or equal to 8 feet bgs and an ending depth greater than 0.5 feet bgs.

The LWOEU subsurface soil samples were analyzed for inorganics (47 samples), organics (28 samples), and radionuclides (20 samples) (Table 1.2). Detected analytes included many inorganics and organics (mostly dioxins but also some solvents), as well as several radionuclides (Table 1.7). The dioxins were present at concentrations less than 1 µg/kg in the two samples that were collected, although most of the dioxins were undetected in one of the samples. A summary of analytes that were not detected, or were detected in less than 5 percent of the subsurface soil samples, is presented in Attachment 1.

1.2 Data Adequacy Assessment

A data adequacy assessment was performed to determine whether the available data set discussed in the previous Section is adequate for risk assessment purposes. The data adequacy assessment rules are presented in the CRA Methodology, and a detailed data adequacy assessment for the data used in the CRA is presented in Appendix A, Volume 2 of the RI/FS Report. The adequacy of the data was assessed by examining the number of available samples for each analyte group in each medium for use in the CRA, the spatial and temporal representativeness of the data, as well as information on potential historical sources of contamination, migration pathways, and the concentration levels in the media. The assessment concludes that the data are adequate for the purposes of the CRA.

1.3 Data Quality Assessment

A data quality assessment (DQA) of the LWOEU data was conducted to determine whether the data were of sufficient quality for risk assessment use. The DQA is presented in Attachment 2, and an evaluation of the entire RFETS data set is presented in Appendix A, Volume 2 of the RI/FS Report. The quality of the laboratory results were evaluated for compliance with the CRA Methodology DQOs through an overall review of precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters. This review concluded that the data are of sufficient quality for use in the CRA and the CRA DQOs have been met.

2.0 SELECTION OF HUMAN HEALTH CONTAMINANTS OF CONCERN

The human health contaminant of concern (COC) screening process is described in Section 4.4 of the CRA Methodology and summarized in Appendix A, Volume 2 of the RI/FS Report (Section 2.2).

The human health COC selection process was conducted for surface soil/surface sediment and subsurface soil/subsurface sediment in the LWOEU. Results of the COC selection process are summarized below.

13

2.1 Contaminant of Concern Selection for Surface Soil/Surface Sediment

Detected PCOCs in surface soil/surface sediment samples (Table 1.3) are screened in accordance with the CRA Methodology to identify the COCs.

2.1.1 Surface Soil/Surface Sediment Cation/Anion and Essential Nutrient Screen

The major cations and anions that do not have toxicity criteria are eliminated from assessments in surface soil/surface sediment in accordance with the CRA Methodology.

The essential nutrient screen for analytes detected in surface soil/surface sediment is presented in Table 2.1. The screen includes PCOCs that are essential for human health and do not have toxicity criteria available. Table 2.1 shows the maximum detected concentrations (MDCs) for essential nutrients, daily intake estimates based on the MDCs, and dietary reference intakes (DRIs). The DRIs are identified in the table as recommended daily allowances (RDAs), recommended daily intakes (RDIs), adequate intakes (AIs), and upper limit daily intakes (ULs). The estimated daily maximum intakes based on the nutrients' MDCs and a surface soil/surface sediment ingestion rate of 100 milligrams per day (mg/day) are less than the DRIs. Therefore, these PCOCs were not further evaluated as COCs for surface soil/surface sediment.

2.1.2 Surface Soil/Surface Sediment Preliminary Remediation Goals Screen

Table 2.2 compares the MDCs and upper confidence limits (UCLs) to the WRW PRGs for each PCOC. If the MDC and the UCL are greater than the PRG, the PCOC is retained for further screening; otherwise, it is not further evaluated. Arsenic, manganese, cesium-134, cesium-137, and radium-228 in surface soil/surface sediment had MDCs and UCLs that exceeded the PRGs and were retained as PCOCs.

PRGs were not available for several PCOCs in surface soil/surface sediment. Analytes without PRGs are listed in Table 2.2, and their effect on the conclusions of the risk assessment results is discussed in the uncertainty Section (Section 6.0).

2.1.3 Surface Soil/Surface Sediment Detection Frequency Screen

Arsenic and manganese were detected in more than 5 percent of surface soil/surface sediment samples and, therefore, were retained for further evaluation in the COC screen (Table 1.3).

The detection frequency screen was not performed for cesium-134, cesium-137, and radium-228 in subsurface soil/subsurface sediment because all reported values for radionuclides are considered detects.

2.1.4 Surface Soil/Surface Sediment Background Analysis

Results of the background statistical comparison for arsenic, manganese, cesium-124, cesium-137, and radium-228 is presented in Table 2.3 and discussed in Attachment 3. Box plots for arsenic, manganese, cesium-134, cesium-137, and radium-228 (both

LWOEU and background) are provided in Attachment 3. Arsenic, manganese, and radium-228 are the PCOCs that were statistically greater than background at the 0.1 significance level and are evaluated further in the professional judgment section.

2.1.5 Surface Soil/Surface Sediment Professional Judgment Evaluation

Based on the weight of available evidence evaluated by professional judgment, PCOCs will either be included for further evaluation as COCs or excluded as COCs. The professional judgment evaluation takes into account process knowledge, spatial trends, pattern recognition comparison to RFETS background and other background data sets, and risk potential to human health and ecological receptors. As discussed in Section 1.2 and Attachment 2, the sample results are adequate for use in the professional judgment because they are of sufficient quality for use in the CRA.

Based on the weight of evidence described in Attachment 3, arsenic, manganese, and radium-228 in surface soil/surface sediment in the LWOEU are not considered COCs because the weight of evidence supports the conclusion that arsenic, manganese, and radium-228 concentrations in surface soil/surface sediment in the LWOEU are not a result of RFETS activities, but rather are representative of naturally occurring concentrations.

2.2 Contaminant of Concern Selection for Subsurface Soil/Subsurface Sediment

Detected PCOCs in subsurface soil/subsurface sediment samples (Table 1.4) are screened in accordance with the CRA Methodology to identify the COCs.

2.2.1 Subsurface Soil/Subsurface Sediment Cation/Anion and Essential Nutrient Screen

The major cations and anions that do not have toxicity criteria were eliminated from assessments in subsurface soil/subsurface sediment in accordance with the CRA Methodology.

Essential nutrients without toxicity criteria that were detected in subsurface soil/subsurface sediment at the LWOEU were compared to DRIs in Table 2.4. The estimated daily maximum intakes for these PCOCs, based on the nutrients' MDCs and a subsurface soil/subsurface sediment ingestion rate of 100 mg/day, are less than the DRIs. Therefore, these PCOCs were not further evaluated as COCs for subsurface soil/subsurface sediment.

2.2.2 Subsurface Soil/Subsurface Sediment Preliminary Remediation Goal Screen

The PRG screen for detected analytes in subsurface soil/subsurface sediment is presented in Table 2.5. The MDC and UCL for radium-228 in subsurface soil/subsurface sediment were greater than the PRG and, therefore, radium-228 was retained for further evaluation in the COC selection process in the LWOEU.

14

PRGs were not available for several PCOCs in subsurface soil/subsurface sediment. Analytes without PRGs are listed in Table 2.5, and their effect on the conclusions of the risk assessment results is discussed in the uncertainty Section (Section 6.0).

2.2.3 Subsurface Soil/Subsurface Sediment Detection Frequency Screen

The detection frequency screen was not performed for radium-228 in subsurface soil/subsurface sediment because all reported values for radionuclides are considered detects.

2.2.4 Subsurface Soil/Subsurface Sediment Background Analysis

Analyses were conducted to asses whether radium-228 activities in LWOEU subsurface soil/subsurface sediment are statistically higher than those in background subsurface soil/subsurface sediment at the 0.1 level of significance (1-p less than or equal to 0.1). The subsurface soil/subsurface sediment background data are described in detail in Appendix A, Volume 2 of the RI/FS Report.

The results of the statistical comparisons of the LWOEU data to the background data indicate site activities for radium-228 are not statistically greater than background at the 0.1 significance level. The results are summarized in Table 2.3 and in Attachment 3. Box plots for radium-228 (both LWOEU and background) are provided in Attachment 3. Radium-228 in subsurface soil/subsurface sediment is not further evaluated in the COC screening process.

2.2.5 Subsurface Soil/Subsurface Sediment Professional Judgment Evaluation

The professional judgment step was not performed for subsurface soil/subsurface sediment because there were no PCOCs with concentrations statistically greater than background concentrations.

2.3 Contaminant of Concern Selection Summary

A summary of the results of the COC screening process is presented in Table 2.6. No COCs were selected for any of the media at the LWOEU.

3.0 HUMAN HEALTH EXPOSURE ASSESSMENT

The site conceptual model (SCM), presented in Figure 2.1 of the CRA Methodology and discussed in Appendix A, Volume 2 of the RI/FS Report, provides an overview of potential human exposures at RFETS for reasonably anticipated land use. However, all PCOCs were eliminated from further consideration as human health COCs for the LWOEU based on comparisons of MDCs and UCLs to PRGs, background comparisons, or professional judgment (see Section 2.0). A quantitative risk characterization is not necessary for the LWOEU and, therefore, an exposure assessment was not conducted.

4.0 HUMAN HEALTH TOXICITY ASSESSMENT

Procedures and assumptions for the toxicity assessment are presented in the CRA Methodology. All PCOCs were eliminated from further consideration as human health COCs for the LWOEU based on comparisons of MDCs and UCLs to PRGs, background comparisons, or professional judgment (see Section 2). A quantitative risk characterization is not necessary for the LWOEU and, therefore, a toxicity assessment was not conducted.

5.0 HUMAN HEALTH RISK CHARACTERIZATION

Information from the exposure assessment and the toxicity assessment is integrated in this Section to characterize risk to the WRW and WRV receptors. All PCOCs were eliminated from further consideration as human health COCs based on comparisons of MDCs and UCLs to PRGs, background comparisons, or professional judgment (see Section 2.0). Therefore, a quantitative risk characterization was not performed for the LWOEU.

6.0 UNCERTAINTIES ASSOCIATED WITH THE HUMAN HEALTH RISK ASSESSMENT

There are various types of uncertainties associated with steps of an HHRA. General uncertainties common to the EUs are discussed in Appendix A, Volume 2 of the RI/FS Report. Uncertainties specific to the EU are described below.

6.1 Uncertainties Associated with the Data

Data adequacy for this CRA is evaluated and discussed in Appendix A, Volume 2 of the RI/FS Report. Although there are some uncertainties associated with the sampling and analyses conducted for surface soil/surface sediment and subsurface soil/subsurface sediment at the LWOEU, data are considered adequate for the characterization of risk at the EU. The environmental samples for the LWOEU were collected from 1991 through 2004. The CRA sampling and analysis requirements for the BZ (DOE 2004, 2005a) specify that the minimum sampling density requirement for surface soil/surface sediment is one five-sample composite for every 30-acre grid cell. In surface soil/surface sediment, there are up to 144 samples in the LWOEU. Although there is limited data for organics in surface soil, there are no known or suspected sources for organic contaminants in the LWOEU. In subsurface soil/subsurface sediment, there are up to 55 samples in the LWOEU.

Another source of uncertainty in the data is the relationship of detection limits to the PRGs for analytes eliminated as COCs because they were either not detected or had a low detection frequency (i.e., less than 5 percent). The detection limits were appropriate for the analytical methods used, and this is examined in greater detail in Attachment 1.

6.2 Uncertainties Associated with Screening Values

The COC screening analyses used RFETS-specific PRGs based on a WRW scenario. The assumptions used in the development of these values were conservative. For example, it is assumed that a future WRW will consume 100 milligrams (mg) of surface soil/surface sediment for 230 days per year for a period of 18.7 years. In addition, a WRW is assumed to be dermally exposed and to inhale surface soil and surface sediment particles in the air. These assumptions are likely to overestimate actual exposures to surface soil for WRWs in the LWOEU because a WRW will not spend 100 percent of his or her time in this area. Exposure to subsurface soil and subsurface sediment is assumed to occur 20 days per year. The WRW PRGs for subsurface soil/subsurface sediment are also expected to conservatively estimate potential exposures because it is unlikely a WRW will excavate extensively in the LWOEU.

6.2.1 Uncertainties Associated with Potential Contaminants of Concern without Preliminary Remediation Goals

PCOCs for the LWOEU for which PRGs are not available are listed in Table 6.1.

Uncertainties associated with the lack of PRGs for analytes listed in Table 6.1 are considered small. The listed inorganics are not usually included in HHRAs because they are not expected to result in significant human health impacts. The listed organics have low detection frequencies and, therefore, are not expected to affect the results of the HHRA. Radionuclide PRGs are available for all detected individual radionuclides. Therefore, the lack of PRGs for the gross alpha and gross beta activities is not expected to affect the results of the HHRA.

6.3 Uncertainties Associated with Eliminating Potential Contaminants of Concern Based on Professional Judgment

Arsenic, manganese, and radium-228 in surface soil/surface sediment were eliminated as COCs based on professional judgment. There is no identified source or pattern of release in the LWOEU, and the slightly elevated median values of arsenic, manganese, and radium-228 in the LWOEU is most likely due to natural variation. The weight of evidence presented in Attachment 3, Section 4.0 supports the conclusion that concentrations of arsenic, manganese, and radium-228 are naturally occurring and do not result from site activities. Uncertainty associated with the elimination of these chemicals as COCs is low.

No PCOCs were eliminated in subsurface soil/subsurface sediment based on professional judgment in the LWOEU.

6.4 Uncertainties Evaluation Summary

An evaluation of the uncertainties associated with the data and the COC screening processes indicates there is reasonable confidence in the conclusions of the LWOEU risk characterization.

7.0 IDENTIFICATION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN

The ECOPC identification process streamlines the ecological risk characterization for each EU by focusing the assessment on ECOIs that are present in the LWOEU. ECOIs are defined as any chemical detected in the LWOEU and are assessed for surface soils and subsurface soils. ECOIs for sediments and surface water are assessed in Appendix A, Volume 15 of the RI/FS Report. The ECOPC process is described in the CRA Methodology and additional details are provided in Appendix A, Volume 2 of the RI/FS Report.

The process is based on the SCM presented in the CRA Methodology and described in detail in Appendix A, Volume 2 of the RI/FS Report. The SCM presents the pathways of potential exposure from documented historical source areas (IHSSs and PACs) to the receptors of concern. Generally, the most significant exposure pathways for wildlife at the LWOEU are the ingestion of plant, invertebrate, or animal tissue that could have accumulated ECOIs from the source areas through direct uptake or dietary routes, as well as the direct ingestion of potentially contaminated media. For terrestrial plants and invertebrates, the most significant exposure pathway is direct contact with potentially contaminated soils.

The receptors of concern that were selected for assessment are listed in Table 7.1 and discussed in detail in Appendix A, Volume 2 of the RI/FS Report. The receptors of concern include representative birds and mammals in addition to the general plant and terrestrial invertebrate communities. The receptors were selected based on several criteria, including their potential to be found in the various habitats present within RFETS, their potential to come into contact with ECOIs, and the amount of life history and behavioral information available.

The ECOPC process consists of two separate evaluations, one for the PMJM receptor and one for non-PMJM receptors. The ECOPC identification process for the PMJM is conducted separately from non-PMJM receptors because the PMJM is a federally listed threatened species under the Endangered Species Act (63 FR 26517).

7.1 Data Used in the Ecological Risk Assessment

The following LWOEU data are used in the CRA:

- Ninety-eight surface soil samples were collected in the LWOEU and analyzed for inorganics (74 samples), organics (nine samples), and radionuclides (98 samples) (Table 1.2).

- Forty-seven subsurface soil samples were analyzed for organics (47 samples), inorganics (28 samples), and radionuclides (20 samples) (Table 1.2).

A data summary is provided in Table 1.5 for surface soil, Table 1.6 for surface soil in PMJM habitat, and Table 1.7 for subsurface soil.

16

Sediment and surface water data for the LWOEU were also collected (Section 1.1.5), and these data are evaluated for the ERA in Appendix A, Volume 15B of the RI/FS Report.

The LWOEU has 40 sample locations occurring in PMJM habitat, which is described in greater detail in Section 1.1.4. Sampling locations and PMJM habitat patches within the LWOEU are shown in Figure 1.5.

7.2 Identification of Surface Soil Ecological Contaminants of Potential Concern

ECOPCs for surface soil were identified for non-PMJM and PMJM receptors in accordance with the sequence presented in the CRA Methodology.

7.2.1 Comparison with No Observed Adverse Effect Level Ecological Screening Levels

In the first step of the ECOPC identification process, the MDCs of ECOIs in surface soil were compared to receptor-specific no observed adverse effect level (NOAEL) ESLs. NOAEL ESLs for surface soil were developed in the CRA Methodology for three receptor groups: terrestrial vertebrates, terrestrial invertebrates, and terrestrial plants.

Non-PMJM Receptors

The NOAEL ESLs for non-PMJM receptors are compared to MDCs in surface soil in Table 7.1. The results of the NOAEL ESL screening analyses for all receptor types are summarized in Table 7.2. Analytes with a "Yes" in any of the "Exceedance" columns in Table 7.2 are evaluated further.

NOAEL ESLs were not available for several ECOI/receptor pairs (Tables 7.1 and 7.2). These ECOI/receptor pairs are discussed as ECOIs with uncertain toxicity (UT) in Section 10.0, along with the potential impacts to the risk assessment.

PMJM Receptors

The NOAEL ESLs for PMJM receptors were compared to the MDCs of ECOIs in surface soil collected from PMJM habitat (Table 7.3). The MDCs in surface soil that exceed the NOAEL ESLs are identified in Table 7.3 with a "Yes" in the column titled "MDC>PMJM ESL?"

Analytes for which a PMJM NOAEL ESL is not available are identified with a "N/A" in Table 7.3 under the column heading "PMJM NOAEL ESL." These analytes are discussed in the uncertainty Section (Section 10.0) as ECOIs with UT.

7.2.2 Surface Soil Frequency of Detection Evaluation

The ECOPC identification process for non-PMJM receptors involves an evaluation of detection frequency for each ECOI retained after the NOAEL screening step. If the detection frequency is less than 5 percent, then population-level risks are considered highly unlikely and the ECOI is not further evaluated. None of the chemicals detected in surface soil at the LWOEU that were retained after the NOAEL ESL screening step had a detection frequency of less than 5 percent. Therefore, no ECOIs were excluded based on the detection frequency evaluation for surface soil in the LWOEU.

7.2.3 Surface Soil Background Comparisons

The ECOIs retained after the NOAEL ESL screening and the detection frequency evaluation were then compared to site-specific background concentrations where available. The background comparisons are presented in Tables 7.4 and 7.5 and discussed in Attachment 3. The statistical methods used for the background comparison are summarized Appendix A, Volume 2 of the RI/FS Report.

Non-PMJM Receptors

The results of the background comparisons for the non-PMJM receptors are presented in Table 7.4. The analytes listed as being retained as an ECOI in Table 7.4 are further evaluated using EPCs in the following section.

PMJM Receptors

The background comparisons for PMJM are conducted differently than for non-PMJM receptors because of their protected status. The results of this comparison are based on the location of the receptors within PMJM habitat and are presented in Table 7.5. Attachment 3 presents further discussion of the PMJM background analysis. The analytes listed as "Yes" in Table 7.5 are further evaluated in the following sections.

7.2.4 Upper-Bound Exposure Point Concentration Comparisons to Threshold ESLs

The ECOIs retained after completion of all previous evaluations for non-PMJM receptors were then compared to threshold ESLs (tESLs) using upper-bound EPCs specific to small and large home-range receptors. The calculation of upper-bound EPCs is described in Appendix A, Volume 2 of the RI/FS Report.

Statistical concentrations for each ECOI retained for the tESL screen are presented in Table 7.6. The EPC for small home-range receptors is the 95 percent UCL of the 90th percentile (upper tolerance limit [UTL]) or the MDC in the event that the UTL is greater than the MDC. The EPC for large home-range receptors is the UCL of the mean, or the MDC in the event that the 95th UCL is greater than the MDC.

Small home-range receptors include terrestrial plants, terrestrial invertebrates, mourning dove, American kestrel, deer mouse, and black-tailed prairie dog. These receptors are evaluated by comparing the small home-range EPC (UTL) for each ECOI to the limiting (or lowest) small home-range receptor tESL (if available). In the event that tESLs are not available, the limiting NOAEL ESL is used in accordance with the CRA Methodology.

Large home-range receptors, such as the coyote and mule deer, are evaluated by comparing the large home-range EPC (UCL) for each ECOI to the limiting large home-range receptor tESL (if available). In the event that tESLs are not available, the limiting NOAEL ESL is used in accordance with the CRA Methodology.

17

The upper-bound EPC comparison to tESLs for small and large home-range receptors is presented in Table 7.7. Analytes that exceed the limiting tESLs are further evaluated by comparing them to the receptor-specific tESLs (if available) to identify receptors of potential concern. Analytes exceeding the limiting tESL for small home-range receptors are compared to receptor-specific tESLs in Table 7.8, and analytes exceeding the limiting tESLs for large home-range receptors are compared to receptor-specific tESLs in Table 7.9.

Chemicals that exceed any tESLs (if available) are assessed in the professional judgment evaluation. Any analyte/receptor pairs that are retained through professional judgment are identified as ECOPCs and are carried forward in the risk assessment.

7.2.5 Surface Soil Professional Judgment Evaluation

Non-PMJM Receptors

Based on the weight of evidence and professional judgment described in Attachment 3, aluminum, antimony, boron, lithium, and zinc in surface soil at the LWOEU were not considered ECOPCs for non-PMJM receptors and, therefore, are not further evaluated quantitatively.

Chromium, copper, manganese, nickel, thallium, tin, and vanadium were identified as ECOPCs and retained for further evaluation in the risk characterization.

PMJM Receptors

Based on the weight of evidence and professional judgment described in Attachment 3, all analytes exceeding screening steps for PMJM receptors were identified as ECOPCs and retained for further evaluation in the risk characterization.

7.2.6 Summary of Surface Soil Ecological Contaminants of Potential Concern

The ECOPC screening process for surface soil is summarized below for non-PMJM receptors and PMJM receptors.

Non-PMJM Receptors

Inorganic, organic, and radionuclide surface soil ECOIs for non-PMJM receptors in the LWOEU were eliminated from further consideration as ECOPCs based on one of the following: 1) the MDC of the ECOI is less than the lowest ESL; 2) no ESLs were available (these ECOIs are discussed in Section 10.0); 3) the concentration of the ECOI in LWOEU surface soils was not greater than background surface soils; 4) the upper-bound EPC did not exceed the limiting tESL; or 5) the weight-of-evidence, professional judgment evaluation indicated that the ECOI was not a site-related contaminant of potential concern. Chemicals that were retained are identified as ECOPCs.

A summary of the ECOPC screening process for non-PMJM receptors is presented in Table 7.10. Receptors of potential concern for each ECOPC are also presented. The ECOPC/receptor pairs are evaluated further in Section 8.0 (Ecological Exposure

Assessment), Section 9.0 (Ecological Toxicity Assessment), and Section 10.0 (Ecological Risk Characterization).

PMJM Receptors

ECOIs in surface soil in PMJM habitat located within the LWOEU were evaluated in the ECOPC identification process. ECOIs were removed from further evaluation in the ECOPC identification process based on one of the following: 1) the MDC of the ECOI was less than the NOAEL ESL for PMJM; 2) no ESLs were available (these ECOIs are discussed in Section 10.0); 3) the ECOI concentrations within the PMJM habitat in LWOEU were not statistically greater than those from background surface soils; or 4) the weight-of-evidence, professional judgment evaluation indicated that the ECOI was not a site-related contaminant of potential concern. The results of the ECOPC identification process for the PMJM are summarized in Table 7.11.

7.3 Identification of Subsurface Soil Ecological Contaminants of Potential Concern

Subsurface soil sampling locations for soil collected at a starting depth of 0.5 to 8 feet bgs in the LWOEU are identified on Figure 1.7.

A data summary for subsurface soil less than 8 feet bgs is presented in Table 1.7.

7.3.1 Comparison to No Observed Adverse Effect Level Ecological Screening Levels

The CRA Methodology indicates subsurface soil must be evaluated for those ECOIs that have greater concentrations in the subsurface than in surface soil. To conduct the most conservative CRA, subsurface soil is evaluated for all EUs regardless of the presence/ absence of a change in concentrations from surface soil and subsurface soil. The MDCs of ECOIs in subsurface soil were compared to NOAEL ESLs for burrowing receptors (Table 7.12). ECOIs with MDCs greater than the NOAEL ESL for the prairie dog are further evaluated in the ECOPC identification process.

NOAEL ESLs are not available for some analytes, and these are identified as “N/A” in Table 7.12. These constituents are considered ECOIs with UT and are discussed in the uncertainty analysis (Section 10.0).

7.3.2 Subsurface Soil Detection Frequency Evaluation

The ECOPC identification process for burrowing receptors involves an evaluation of detection frequency for each ECOI retained after the NOAEL ESL screening step. If the detection frequency is less than 5 percent, population-level risks are considered highly unlikely and the ECOI is further evaluated. The detection frequencies for chemicals in subsurface soil are presented in Table 1.7. None of the chemicals in subsurface soil at the LWOEU that were retained after the NOAEL ESL screening step had a detection frequency of less than 5 percent. Therefore, no ECOIs were eliminated from further evaluation based on the detection frequency for subsurface soil in the LWOEU.

18

7.3.3 Subsurface Soil Background Comparison

The ECOIs retained after the NOAEL ESL screening and the detection frequency evaluation were then compared to site-specific background concentrations where available. The background comparisons are presented in Table 7.13 and discussed in Appendix A, Volume 2 of the RI/FS Report. The statistical methods used for the background comparison are summarized in Appendix A, Volume 2 of the RI/FS Report.

The analytes listed as being retained as ECOIs in Table 7.13 are evaluated further using upper-bound EPCs in the following section.

7.3.4 Upper-Bound Exposure Point Concentration Comparisons to Threshold ESLs

ECOIs retained after all previous evaluations for burrowing receptors are compared to tESLs using upper-bound EPCs specific to small home-range receptors. The calculation of upper-bound EPCs is discussed in Appendix A, Volume 2 of the RI/FS Report.

Statistical concentrations for each ECOI retained for the tESL screen are presented in Table 7.14. The upper-bound EPC comparison to tESLs for burrowing receptors is presented in Table 7.15.

7.3.5 Subsurface Soil Professional Judgment

ECOIs with subsurface soil concentrations that exceed NOAEL ESLs, which have been detected in more than 5 percent of the samples; are statistically higher at the 0.1 level of significance compared to the background data; and exceed tESLs are subject to a professional judgment evaluation. The weight-of-evidence, professional judgment evaluation takes into consideration several factors, as described in Attachment 3.

Based on the weight of evidence and professional judgment, all remaining ECOIs in subsurface soil in the LWOEU are not considered ECOPCs and are not further evaluated quantitatively.

7.3.6 Summary of Subsurface Soil Ecological Contaminants of Potential Concern

All subsurface soil ECOIs for burrowing receptors in the LWOEU were eliminated from further consideration as ECOPCs. These decisions were based on one of the following: 1) the MDC of the ECOI is less than NOAEL ESL for the burrowing receptor; 2) no ESLs were available (these ECOIs are discussed in Section 10.0; 3) the concentration of the ECOI in LWOEU subsurface soils was not greater than background subsurface soils; 4) the upper-bound EPC was less than the tESL; or 5) the weight-of-evidence, professional judgment evaluation indicated that the ECOI was not a site-related contaminant of potential concern. The results of the subsurface soil ECOPC identification process for burrowing receptors are summarized in Table 7.16.

7.4 Summary of Ecological Contaminants of Potential Concern

ECOIs in surface and subsurface soil in the LWOEU were evaluated in the ECOPC identification process for non-PMJM receptors, PMJM receptors, and burrowing receptors. Chromium, copper, manganese, nickel, thallium, tin, and vanadium were identified as ECOPCs for selected non-PMJM receptors (Table 7.10). Chromium, copper, manganese, nickel, selenium, tin, vanadium, and zinc were identified as ECOPCs for the PMJM (Table 7.11). No chemicals were identified as ECOPCs for burrowing receptors (Table 7.16). No other ECOIs were retained past the professional judgment step of the ECOPC identification process for any other receptor group (non-PMJM receptors, PMJM receptors, or burrowing receptors).

8.0 ECOLOGICAL EXPOSURE ASSESSMENT

The ECOPC identification process defined the steps necessary to identify those chemicals that could not reliably be removed from further consideration in the ERA process. The list of ECOPC/receptor pairs of potential concern (Table 8.1) represents those media, chemicals, and receptors in the LWOEU that require further assessment. The characterization of risk defines a range of potential exposures to site receptors from the ECOPCs and a parallel evaluation of the potential toxicity of each of the ECOPCs, as well as the uncertainties associated with the risk characterization. This Section provides the estimation of potential exposure to surface soil ECOPCs for the receptors identified in Section 7.0 and Table 8.1. Details of the two exposure models, concentration-based exposure and dosage-based exposure, are presented in Appendix A, Volume 2 of the RI/FS Report.

8.1 Exposure Point Concentrations

Surface soil EPCs for all non-PMJM receptors were calculated using both Tier 1 and Tier 2 methods, as described in the CRA Methodology. The 30-acre grid used for the Tier 2 calculations is shown in Figure 8.1. The Tier 1 and Tier 2 UTLs and UCLs are presented in Table 8.2. The methodology for the calculation of Tier 2 statistics is provided in Appendix A, Volume 2, Attachment 2 of the RI/FS Report

Surface soil EPCs for PMJM receptors were calculated for each PMJM habitat patch, assuming that all samples were randomly located and weighted equally. The habitat patches showing sample locations exceeding the NOAEL ESL, or three times the NOAEL ESL, are shown for ECOPCs in Figure 8.2 (chromium), Figure 8.3 (copper), Figure 8.4 (manganese), Figure 8.5 (nickel), Figure 8.6 (selenium), Figure 8.7 (tin), Figure 8.8 (vanadium), and Figure 8.9 (zinc). The UCL concentrations for each ECOPC was used as EPCs to calculate hazard quotients (HQs). The UCL was not used if there were not sufficient numbers of samples to calculate this value or if it exceeded the MDC. In either case, the MDC was used as a surrogate EPC. The surface soil EPCs for each PMJM patch are presented in Table 8.3. The ECOPCs shown in Table 8.3 represent ECOPCs with patch-specific MDCs greater than their respective ESLs. All ECOPCs that

19

are not detected in a specific patch at concentrations less than their ESLs are excluded from the table.

Surface water EPCs consisted of values that correspond to the soil EPCs (only for the soil ECOPCs) being used and are used to estimate the total exposure via the surface water ingestion pathway. For example, if the soil EPC statistic was the UCL, then the UCL concentration in surface water (total values only) was selected as the EPC. Surface water EPCs for all ECOPCs were calculated as described for soils and are presented in Table 8.4. All surface water data are provided on a CD in Attachment 6.

8.2 Receptor-Specific Exposure Parameters

Receptor-specific exposure factors are needed to estimate exposure to ECOPCs for each representative species. These include body weight; food, water, and media ingestion rates; and diet composition and respective proportion of each dietary component. Daily rates for intake of forage, prey, water, and incidental ingestion of soils were developed in the CRA Methodology and are presented in Table 8.5 for the receptors of potential concern carried forward in the ERA for the LWOEU.

8.3 Bioaccumulation Factors

The measurement or estimation of concentrations of ECOPCs in-wildlife food is necessary to evaluate how much of a receptor's exposure is via food versus direct uptake of contaminated media. Conservative bioaccumulation factors (BAFs) were identified in the CRA Methodology. These BAFs are either simple ratios between chemical concentrations in biota and soil or are based on quantitative relationships such as linear, logarithmic, or exponential equations. The values reported in the CRA Methodology are used as the BAFs for purposes of risk estimation.

8.4 Intake and Exposure Estimates

Intake and exposure estimates were completed for each ECOPC/receptor pair identified in Table 8.1. The "default" estimates use the default exposure parameters and BAFs presented in Appendix B of the CRA Methodology and described in the previous subsection. These intake calculations represent conservative estimates of food tissue concentrations calculated from the range of upper-bound EPCs, including the Tier 1 and Tier 2 UTLs and UCLs where appropriate.

Non-PMJM Receptors

The intake and exposure estimates for ECOPC/non-PMJM receptor pairs are presented in Attachment 4. A summary of the exposure estimates is presented in Table 8.6.

- Chromium – Exposure estimates for the American kestrel, mourning dove (herbivore and insectivore), and deer mouse (insectivore);
- Copper – Exposure estimates for the mourning dove (herbivore and insectivore);
- Manganese – Exposure estimates for the deer mouse (herbivore);

- Nickel – Exposure estimates for the mourning dove (insectivore), deer mouse (herbivore and insectivore), and coyote (generalist and insectivore);
- Tin – Exposure estimates for the mourning dove (herbivore and insectivore), American kestrel, and deer mouse (insectivore); and
- Vanadium – Exposure estimates for the deer mouse (insectivore).

PMJM Receptors

The intake and exposure estimates for ECOPC/PMJM receptor pairs are presented in Attachment 4 and are summarized in Table 8.7 for:

- Chromium;
- Copper;
- Manganese;
- Nickel;
- Selenium;
- Tin;
- Vanadium; and
- Zinc.

9.0 ECOLOGICAL TOXICITY ASSESSMENT

Exposure to wildlife receptors was estimated for representative species of functional groups based on taxonomy and feeding behavior, in Section 8.0, in the form of a daily rate of intake for each ECOPC/receptor pair. To estimate risk, soil concentrations (plants and invertebrate exposure) and calculated intakes (birds and mammals) must then be compared to the toxicological properties of each ECOPC. The laboratory-based toxicity benchmarks are termed toxicity reference values (TRVs) and are of several basic types. The NOAEL and no observed effect concentration (NOEC) TRVs are intake rates or soil concentrations below which no ecologically significant effects are expected. The NOAEL and NOEC TRVs were used to calculate the NOAEL ESLs used in screening steps of the ECOPC identification process to eliminate chemicals that have no potential to cause risk to the representative receptors. The lowest observed adverse effects level (LOAEL) TRV is a concentration above which the potential for some ecologically significant adverse effect could be elevated. The threshold TRVs represent the hypothetical dose at which the response for a group of exposed organisms may first begin to be significantly greater than the response for unexposed receptors and are calculated as the geometric mean of the NOAEL and LOAEL. Threshold TRVs were calculated based on specific data quality rules for use in the ECOPC identification process for a small subset of ECOIs in the CRA Methodology.

10

TRVs for ECOPCs identified for LWOEU were obtained from the CRA Methodology. The pertinent TRVs for the LWOEU are presented for terrestrial plants and invertebrates in Table 9.1 and for birds and mammals in Table 9.2.

10.0 ECOLOGICAL RISK CHARACTERIZATION

Risk characterization includes risk estimation and risk description. Details of these components are described in the CRA Methodology and Appendix A, Volume 2 of the RI/FS Report. Predicted risks should be viewed in terms of the potential for the assumptions used in the risk characterization to occur in nature, the uncertainties associated with the assumptions, and in the potential for effects on the population of receptors that could inhabit the LWOEU.

Potential risks to terrestrial plants, invertebrates, birds, and mammals are evaluated using a HQ approach. An HQ is the ratio of the estimated exposure of a receptor to a TRV that is associated with a known level of toxicity, either a no effect level (NOAEL or NOEC) or an effect level (LOAEL or [lowest effects concentration] LOEC):

$$HQ = Exposure / TRV$$

As described in Section 8.0, the units used for exposure and TRV depend upon the type of receptor evaluated. For plants and invertebrates, exposures and TRVs are expressed as concentrations (milligram per kilogram [mg/kg] soil). For birds and mammals, exposures and TRVs are expressed as ingested doses (mg/kg/receptor body weight [BW]/day). In general, if the NOAEL-based HQ is less than 1, then no adverse effects are predicted. If the LOAEL-based HQ is less than 1 but the NOAEL-based HQ is above 1, then some adverse effects are possible, but it is expected that the magnitude and frequency of the effects will usually be low (assuming the magnitude and severity of the response at the LOAEL are not large and the endpoint of the LOAEL accurately reflects the assessment endpoints for that receptor). If the LOAEL-based HQ is greater than or equal to 1, the risk of an adverse effect is of potential concern, with the probability and/or severity of effect tending to increase as the value of the HQ increases.

When interpreting HQ results for non-PMJM ecological receptors, it is important to remember that the assessment endpoint to non-PMJM receptors is based on the sustainability of exposed populations, and risks to some individuals in a population may be acceptable if the population is expected to remain healthy and stable. For threatened and endangered species, such as the PMJM, the interpretation of HQ results is based on potential risks to individuals rather than to populations.

HQs were calculated for each ECOPC/receptor pair based on the exposures estimated and TRVs presented in the preceding sections. Risks are discussed and presented to put the assumptions of the risk predictions into a context that can be used to make risk management decisions.

10.1 Chemical Risk Characterization

Chemical risk characterization uses quantitative methods to evaluate potential risks to ecological receptors. In this risk assessment, the quantitative method used to characterize chemical risk is the HQ approach. As noted above, HQs are usually interpreted as follows:

HQ Values		Interpretation of HQ Results
NOAEL-based	LOAEL-based	
≤ 1	≤ 1	Minimal or no risk
> 1	≤ 1	Low level risk[a]
> 1	> 1	Potentially significant risk

[a] Assuming magnitude and severity of response at LOAEL are relatively small and based on endpoints appropriate for the assessment endpoint of the receptor considered.

One potential limitation of the HQ approach is that calculated HQ values may sometimes be uncertain due to simplifications and assumptions in the underlying exposure and toxicity data used to derive the HQs. Where possible, this risk assessment provides information on three potential sources of uncertainty, described below.

- **EPCs.** Because surface soil sampling programs in the EU sometimes tended to focus on areas of potential contamination (IHSS/PAC/UBCs), EPCs calculated using the Tier 1 approach (which assumes that all samples are randomly spread across the EU and are weighted equally) may tend to yield an EPC that is biased high. For this reason, a Tier 2 area-weighting approach was used to derive additional EPCs that help compensate for this potential bias. HQs were always calculated based on Tier 1 and Tier 2 EPCs for non-PMJM receptors. No Tier 2 EPCs were calculated for PMJM receptors due to the limited size of their habitat.

- **BAFs.** For wildlife receptors, concentrations of contaminants in dietary items were estimated from surface soil using uptake equations. When the uptake equation was based on a simple linear model (e.g., $C_{tissue} = BAF * C_{soil}$), the default exposure scenario used a high-end estimate of the BAF (the 90th percentile BAF). However, the use of high-end BAFs may tend to overestimate tissue concentrations in some dietary items. To estimate more typical tissue concentrations, where necessary, an alternative exposure scenario calculated total chemical intake using a 50th percentile (median) BAF, and HQs were calculated. The use of the median BAF is consistent with the approach used in the ecological soil screening level (EcoSSL) guidance (EPA 2005).

21

- **TRVs.** The CRA Methodology used an established hierarchy to identify the most appropriate default TRVs for use in the ECOPC selection. However, in some instances, the default TRV selected may be overly conservative with regard to characterizing population-level risks. The determination of whether the default TRVs are thought to yield overly conservative estimates of risk is addressed in the uncertainty sections below on a chemical-by-chemical basis. When an alternative TRV is identified, the chemical-specific uncertainty sections provide a discussion of why the alternative TRV is thought to be appropriate to provide an alternative estimate of toxicity (e.g., endpoint relevance, species relevance, data quality, chemical form, etc.), and HQs were calculated using both default and alternative TRVs where necessary.

The influences of each of these uncertainties on the calculated HQs were evaluated, both alone and in concert, in the risk description for each chemical. Uncertainties related to the BAFs, TRVs, and background risk are presented for each chemical in Attachment 5. Where uncertainties were deemed to be high, Attachment 5 provided alternative BAFs and/or TRVs as appropriate based on the results of the uncertainty assessment.

HQs calculated using the default BAFs and HQs with the Tier 1 and Tier 2 EPCs are provided in Tables 10.1 and 10.2 for each ECOPC/receptor pair. Where no LOAEL HQs exceed 1 using the default exposure and toxicity values, no further HQs were calculated regardless of the results of the uncertainty analysis. Because the default HQs are generally the most conservative risk estimations, if low risk is estimated using these values then further reductions of conservatism would only serve to further reduce risk estimates.

Where LOAEL HQs greater than 1 are calculated using default assumptions, and the uncertainty analysis indicated that alternative BAFs and/or TRVs would be beneficial to reduce uncertainty and conservatism, alternative HQs are presented in Table 10.1 as appropriate.

The selection of which EPC (e.g., UTL or UCL) is of primary importance will depend upon the type of receptor and the relative home-range size. Only the UTL EPC is provided in Table 10.1 for small home-range receptors, and only the UCL is provided for large home-range receptors. The patch-specific UCL is provided in Table 10.2 for the PMJM receptors.

All calculated exposure estimates and HQ values are also provided in Attachment 4. These include the default and alternative HQs and are calculated using a range of EPCs. The results for each ECOPC are discussed in more detail below.

The risk description incorporates results of the risk estimates along with the uncertainties associated with the risk estimations and other lines of evidence to evaluate potential chemical effects on ecological receptors in the LWOEU following accelerated actions. Information considered in the risk description includes receptor groups potentially affected, type of TRV exceeded (e.g., NOAEL versus LOAEL), relation of EU concentrations to other criteria such as EPA EcoSSLs, and risk above background conditions. In addition, other site-specific and regional factors are considered such as the use of a given ECOPC within the EU related to historical RFETS activities, comparison of ECOPC concentrations within the LWOEU to the rest of the RFETS site as it relates to background, and/or comparison to regional background concentrations.

10.1.1 Chromium

Chromium HQs for the terrestrial plants, terrestrial invertebrates, mourning dove (herbivore and insectivore), American kestrel, and deer mouse (insectivore) are presented in Table 10.1. Figure 10.1 shows the spatial distribution of chromium in relation to the lowest ESL and also presents the data used in the calculation of the Tier 2 EPCs. Patch-specific HQs for the PMJM receptor (Patches #22 and #23) are presented in Table 10.2.

HQs Calculated to Characterize Uncertainty

Uncertainties related to the default HQ calculations provided in Table 10.1 are discussed in detail in Attachment 5. Uncertainties related to BAFs, TRVs, and background risks are presented.

For non-PMJM receptors, because only the terrestrial plant, terrestrial invertebrate, and mourning dove (insectivore) receptors had LOAEL HQs greater than 1 using the default exposure assumptions, alternative HQs were only calculated for those receptors. Those alternative HQs are presented in Table 10.1.

However, care should be taken to review the chemical-specific uncertainties discussed in Attachment 5 when reviewing the results of all receptors regardless of whether alternative HQs are provided.

Chromium Risk Description

Chromium was identified as an ECOPC for terrestrial plants, terrestrial invertebrates, mourning dove (herbivore and insectivore), American kestrel, deer mouse (insectivore), and PMJM receptors. Alternative HQs were calculated for the terrestrial plant, terrestrial invertebrate, and mourning dove (insectivore) receptors using alternative TRVs for plants and invertebrates and a median soil-to-invertebrate BAF for the mourning dove (insectivore). Information on the historical use and a summary of site data and background data are provided in Attachment 3.

Terrestrial Plants and Invertebrates

For terrestrial plants, HQs were greater than 1 using the default ESL. The UTL HQ equaled 26 indicating that risks could not be considered to be minimal. Because no default LOEC value was available, it is uncertain whether risks have the potential to be significant based on the default HQ calculations.

The uncertainty assessment discussed the low confidence placed in the chromium ESL for terrestrial plants and provided an alternative NOEC and LOEC value. The alternative NOEC had an HQ greater than 1, while no HQs greater than 1 were calculated using the alternative LOEC. As discussed in the uncertainty analysis, the alternative LOEC is representative of a concentration at which soybean roots had a 30 percent reduction in shoot weight.

22

The default ESL is less than all site-specific background concentrations. HQs greater than 1 were calculated using UTL background concentration (HQ = 17). Because risks are not generally expected in background areas, risks to terrestrial plants may be somewhat over-predicted using the default ESL. Attachment 3 of this document indicates that the background concentrations of chromium in Colorado and the bordering states range from 3 to 500 mg/kg, with an average concentration of 18.2 mg/kg. The site-specific background MDC is equal to 6.9 mg/kg and does not appear to be elevated above what would be expected in the vicinity of the site.

The low confidence placed in the ESL and the lack of exceedance of any effects-based TRVs, and the conservatisms noted in the default ESL, all indicate that the potential for risk to terrestrial plant populations in the LWOEU from exposure to chromium in surface soils is likely to be low.

For terrestrial invertebrates, HQs greater than 1 were calculated using the default ESL, indicating that risks could not be considered to be minimal. Because no default LOEC value was available, it is uncertain whether risks have the potential to be significant based on the default HQ calculations.

The uncertainty assessment indicated that the default ESL is less than all site-specific background concentrations. HQs greater than 1 were calculated using UTL background concentration (HQ = 42). Because risks are not generally expected in background areas, the chromium ESL for terrestrial invertebrates may be over-predicted. As discussed above, site-specific background concentrations do not appear to be elevated above what would be expected in the vicinity of the site.

The maximum HQ calculated using the alternative LOEC, identified in the uncertainty analysis, equaled 0.8. The alternative LOEC is representative of a concentration at which a 30 percent reduction in earthworm growth was noted.

The low confidence placed in the ESL and the lack of exceedance of any effects-based TRVs indicate that the potential for risk to terrestrial invertebrate populations in the LWOEU from exposure to chromium in surface soils is likely to be low.

Non-PMJM Receptors – Small Home-Range

NOAEL HQs using default risk models were greater than 1 for the mourning dove (insectivore), American kestrel, and deer mouse (insectivore) (chromium VI TRV only). NOAEL HQs were less than or equal to 1 for the mourning dove (herbivore). All LOAEL HQs were less than 1 for all receptors except the mourning dove (insectivore). Risks to populations of the mourning dove (herbivore), American kestrel, and deer mouse (insectivore) from exposure to chromium are likely to be low. Risks to the mourning dove (insectivore) using the default HQ calculations may potentially be significant and require further evaluation.

Table 10.3 presents a summary of HQs calculated using the arithmetic mean concentration used as cell-specific EPCs for surface soil samples within each of the Tier 2 30-acre grid cells. Default NOAEL and LOAEL TRVs were used in the HQ calculations. Chromium samples were available from 26 grid cells (Figure 10.1). NOAEL and LOAEL HQs greater than 1 were calculated in 100 percent of the grid cells, while no LOAEL HQs greater than 5 were calculated in any grid cell for the most sensitive receptor (mourning dove [insectivore]). The results of the grid-cell analysis indicate that the average exposure to sub-populations of mourning dove (insectivore) results in low to moderate risk from exposure to chromium.

The uncertainty analysis indicated that exposure to the mourning dove (insectivore) may be overestimated based on the use of upper-bound BAFs. Table 10.1 presents HQs calculating using the identical model and TRVs as used in the default but with a median BAF rather than the conservative 90th percentile BAF. The mourning dove (insectivore) had an NOAEL HQ greater than 1 (HQ = 2) and an LOAEL HQ less than 1. These results provide a less conservative measure of potential intake and support the conclusions reached using the default HQ calculation. The results also indicate that risks to the mourning dove (insectivore) may be over-predicted using the default HQ calculations. In addition, background risk evaluations also indicated similar HQs for the mourning dove (insectivore) using the default HQ calculations. The combined lines of evidence suggest the overestimation of risk using the default HQ calculations. Risks are, therefore, expected to be low to populations of the mourning dove (insectivore).

PMJM Receptor

Chromium was identified as an ECOPC for the PMJM receptor in Patches #22 and #23. Sample locations within PMJM habitat and a comparison to the ESL are shown in Figure 8.2. HQs equal to 1 were calculated using the NOAEL TRV for chromium VI in Patches #22 and #23. All NOAEL HQs were less than 1 in all patches when the chromium III TRV was used in the HQ calculation. No LOAEL HQs greater than 1 were calculated in any patch using the conservative chromium VI TRV.

No alternative HQ calculations were provided because risks to the PMJM receptor are likely to be low based on the most conservative HQ calculations.

10.1.2 Copper

Copper HQs for the mourning dove (herbivore and insectivore) are presented in Table 10.1. Copper was not identified as an ECOPC in the LWOEU for any other receptors. Figure 10.2 shows the spatial distribution of copper in relation to the lowest ESL and also presents the data used in the calculation of the Tier 2 EPCs. Patch-specific HQs for the PMJM receptor (Patches #22 and #23) are presented in Table 10.2.

HQs Calculated to Characterize Uncertainty

Uncertainties related to the default HQ calculations provided in Table 10.1 are discussed in detail in Attachment 5. Uncertainties related to BAFs, TRVs, and background risks are presented.

For non-PMJM receptors, no receptors had LOAEL HQs greater than 1 using the default exposure assumptions and no alternative HQs were calculated. For PMJM receptors, no NOAEL or LOAEL HQs greater than 1 were calculated in Patch #23 using the default HQ calculations. Therefore, no alternative HQs were calculated.

23

However, care should be taken to review the chemical-specific uncertainties discussed in Attachment 5 when reviewing the results of all receptors regardless of whether alternative HQs are provided.

Copper Risk Description

Copper was identified as an ECOPC for the mourning dove (herbivore and insectivore) and PMJM receptors only. Information on the historical use and a summary of site data and background data are provided in Attachment 3.

Non-PMJM Receptors – Small Home-Range

NOAEL HQs calculated using Tier 1 EPCs were equal to 1 for the mourning dove (herbivore) for the UTL but less than 1 for the UCL. NOAEL HQs for the mourning dove (insectivore) were greater than 1 for the Tier 1 UTL only (HQ = 2) and equal to 1 for Tier 2 UTL.

All LOAEL HQs were less than 1 for both receptors. Risks to populations of receptors from exposure to copper in LWOEU surface soils are, therefore, considered to be low.

Table 10.3 presents a summary of HQs calculated using the arithmetic mean concentration used as cell-specific EPCs for surface soil samples within each of the Tier 2 30-acre grid cells. Default NOAEL, threshold, and LOAEL TRVs were used in the HQ calculations. Copper samples were available from 26 grid cells (Figure 10.2). NOAEL HQs greater than 1 were calculated in 100 percent of the grid cells while no LOAEL HQs greater than 1 were calculated in any grid cell for the most sensitive receptor (mourning dove [insectivore]). The results of the grid-cell analysis indicate that the average exposure to sub-populations of mourning dove (insectivore) results in low risk from exposure to copper.

Uncertainties associated with background risks, BAFs, and TRVs used in the default HQ calculations are discussed in Attachment 5. No significant uncertainties were identified and no alternative HQ calculations were recommended.

In conclusion, risks to the mourning dove (herbivore and insectivore) are likely to be low from exposure to copper in surface soils in the LWOEU.

PMJM Receptor

Copper was identified as an ECOPC for the PMJM receptor in Patch #23 only. Sample locations within PMJM habitat and a comparison to the ESL are shown in Figure 8.3. No NOAEL or LOAEL HQs greater than 1 were calculated using the Patch #23 using the UCL EPC. This indicates that risks are likely to be low to PMJM receptors in the LWOEU.

No alternative HQ calculations were provided because risks to the PMJM receptor are likely to be low based on the most conservative HQ calculations.

10.1.3 Manganese

Manganese HQs for the terrestrial plants and deer mouse (herbivore) receptors are presented in Table 10.1. Figure 10.3 shows the spatial distribution of manganese in relation to the lowest ESL and also presents the data used in the calculation of the Tier 2 EPCs. Patch-specific HQs for the PMJM receptor (Patches #22, #23, and #27) are presented in Table 10.2.

HQs Calculated to Characterize Uncertainty

Uncertainties related to the default HQ calculations provided in Table 10.1 are discussed in detail in Attachment 5. Uncertainties related to BAFs, TRVs, and background risks are presented.

For non-PMJM receptors, no receptors had LOAEL HQs greater than 1 using the default exposure assumptions, and no alternative HQs were calculated.

The UCL for all patches of PMJM habitat had NOAEL HQs less than 3 and no LOAEL HQs greater than 1. Therefore, no alternative HQ calculations are necessary.

However, care should be taken to review the chemical-specific uncertainties discussed in Attachment 5 when reviewing the results of all receptors regardless of whether alternative HQs are provided.

Manganese Risk Description

Manganese was identified as an ECOPC for the deer mouse (herbivore) and PMJM receptors only. Information on the historical use and a summary of site data and background data are provided in Attachment 3.

Non-PMJM Receptors – Small Home-Range

NOAEL HQs calculated using the Tier 1 EPC were equal to 1 for the deer mouse (herbivore) and terrestrial plants for the UTL. The Tier 2 UTL NOAEL HQs were less than 1 for both receptors. All LOAEL HQs for the deer mouse (herbivore) were less than 1. Risks to populations of non-PMJM receptors from exposure to manganese in LWOEU surface soils are, therefore, considered to be low.

Uncertainties associated with background risks, BAFs, and TRVs used in the default HQ calculations are discussed in Attachment 5. No significant uncertainties were identified, and no alternative HQ calculations were recommended.

Table 10.3 presents a summary of HQs calculated using the arithmetic mean concentration used as cell-specific EPCs for surface soil samples within each of the Tier 2 30-acre grid cells. Default NOAEL and LOAEL TRVs were used in the HQ calculations. Manganese samples were available from 26 grid cells (Figure 10.3). NOAEL HQs greater than 1 were calculated in any 8 percent of grid cells for the most sensitive receptor (deer mouse (herbivore)). No LOAEL HQs greater than 1 were calculated in any grid cell. The results of the grid-cell analysis indicate that the average exposure to sub-populations of deer mouse (herbivore) results in low risk from exposure to manganese.

24

PMJM Receptor

Manganese was identified as an ECOPC for the PMJM receptor in Patches #22, #23, and #27. Sample locations within PMJM habitat and a comparison to the ESL are shown in Figure 8.4. HQs greater than 1 were calculated using the NOAEL TRV for manganese in Patches #22, #23, and #27. Patch #23 had the highest HQ with the UCL HQ equal to 2. No LOAEL HQs greater than 1 were calculated in any patch using the default HQ calculations. This indicates that risks are likely to be low to PMJM receptors in the LWOEU.

No alternative HQ calculations were provided because risks to the PMJM receptor are likely to be low based on the most conservative HQ calculations.

10.1.4 Nickel

Nickel HQs for the mourning dove (insectivore), deer mouse (herbivore and insectivore), and coyote (generalist and insectivore) are presented in Table 10.1. Figure 10.4 shows the spatial distribution of nickel in relation to the lowest ESL and also presents the data used in the calculation of the Tier 2 EPCs. Patch-specific HQs for the PMJM receptor (Patches #22, #23, #24, and #27) are presented in Table 10.2.

HQs Calculated to Characterize Uncertainty

Uncertainties related to the default HQ calculations provided in Table 10.1 are discussed in detail in Attachment 5. Uncertainties related to BAFs, TRVs, and background risks are presented.

For non-PMJM receptors, only the deer mouse (insectivore) had LOAEL HQs greater than 1, indicating that risks based on the default assumptions could have the potential to be significant. However, the uncertainty analysis presented in Attachment 5 indicated that there were considerable uncertainties and conservatisms in the nickel risk calculations based on both upper-bound BAFs and TRVs that resulted in potentially significant risk at background concentrations. For this reason, alternative HQs were calculated for the deer mouse (insectivore) using both median BAFs and the alternative BAFs presented in the uncertainty analysis. The resulting HQs are presented in Table 10.1

For PMJM receptors, LOAEL HQs greater than 1 were calculated using the UCL EPC in all of the patches in which nickel was an ECOPC, indicating that risks based on the default assumptions have the potential to be significant. However, as discussed above, the uncertainty analysis presented in Attachment 5 indicated that there were considerable uncertainties and conservatisms in the nickel risk calculations based on both upper-bound BAFs and TRVs that resulted in potentially significant risk at background concentrations. For this reason, alternative HQs were calculated for the PMJM using both median BAFs and the alternative BAFs presented in the uncertainty analysis. The resulting HQs are presented in Table 10.2.

Although risks to all receptors except the deer mouse (insectivore) and PMJM receptors were determined to be low using the more conservative default HQs, care should be taken to review the chemical-specific uncertainties discussed in Attachment 5 when reviewing the results of all receptors regardless of whether alternative HQs are provided.

Nickel – Risk Description

Nickel was identified as an ECOPC for the mourning dove (insectivore), deer mouse (herbivore and insectivore), PMJM, and coyote (generalist and insectivore). Information on the historical use and a summary of site data and background data are provided in Attachment 3.

Non-PMJM Receptors – Small Home-Range

For the non-PMJM receptors, NOAEL HQs were greater than 1 for the mourning dove (insectivore) and deer mouse (herbivore and insectivore) under the default exposure/TRV scenarios (Table 10.1). Threshold HQs were also greater than 1 for the mourning dove under default exposure/TRV scenarios. LOAEL HQs for all non-PMJM receptors (except deer mouse [insectivore]) were, however, less than or equal to 1 under the default exposure scenario. The deer mouse (insectivore) had LOAEL HQs greater than 1 under the default exposure scenarios (HQ ranged from 3 to 4 depending on the EPC) indicating that potentially significant risks are predicted under the default exposure scenario. Risks to the mourning dove (insectivore), deer mouse (herbivore) and coyote (generalist and insectivore) are all likely to be low because no LOAEL HQs greater than 1 were calculated using the default BAFs and TRVs prescribed by the CRA Methodology. Risks to the deer mouse (insectivore) require more evaluation based on the results of the uncertainty analysis.

Table 10.3 presents a summary of HQs calculated using the arithmetic mean concentration used as cell-specific EPCs for surface soil samples within each of the Tier 2 30-acre grid cells. Default NOAEL and LOAEL TRVs were used in the HQ calculations. Nickel samples were available from 26 grid cells (Figure 10.4). NOAEL HQs greater than 10 were calculated in 100 percent of the grid cells. LOAEL HQs greater than 1 but less than 5 were also calculated in 92 percent of grid cells and between 5 and 10 in 8 percent of grid cells (n=2) for the most sensitive receptor (deer mouse [insectivore]). The results of the grid-cell analysis indicate that risks from average exposure to sub-populations of insectivorous small mammals cannot be dismissed and also requires further evaluation.

The uncertainty analysis discussed the potential for risks to be overestimated using the default exposure models and TRVs due to LOAEL HQs greater than 1 calculated at UCL and UTL background soil concentrations. Because risks are not generally expected in background concentrations, particularly at the low end of the range of background concentrations, the uncertainty analysis recommended several steps to provide a less uncertain assessment of risks. Background concentrations of nickel (MDC = 14.0 mg/kg) do not appear to be elevated over what would be expected in the vicinity of the site. Attachment 3 presents background concentrations for Colorado and the bordering states where nickel concentrations range from 5 to 700 mg/kg with an average of 18.8 mg/kg.

For the deer mouse (insectivore), LOAEL HQs in background (UTL HQs = 3) are similar to those calculated for LWOEU surface soils with the exception of the Tier 1 UTL (HQ = 5). These results indicate that risks to insectivorous deer mouse populations within LWOEU are similar to those off site. This also indicates that risk estimates to the deer

25

mouse (insectivore) receptor using the default exposure factors and TRVs may be overly conservative and are not different from those predicted at background concentrations.

The uncertainty analysis discussed these uncertainties and conservatisms related to both upper-bound BAFs used in the intake estimates and in the TRVs used to calculate HQs. Alternative intake rates were calculated for those receptors ingesting invertebrates in their diet. In addition, HQs were also calculated using alternative TRVs from Sample et al. (1996).

No LOAEL HQs greater than 1 were calculated using the default TRVs under the alternative (median) BAF exposure scenario. In addition, no HQs greater than 1 were calculated for any receptor using either the alternative NOAEL or LOAEL TRV under the default BAF scenario or the alternative BAF scenario.

Risks to the deer mouse (insectivore) may be slightly higher than those predicted for the other receptors. However, while the TRVs used for the NOAEL and LOAEL appear to be sound TRVs based on appropriate endpoints, the exposure models used in the assessment result in elevated risks as minimum background concentrations using those TRVs. When the upper-bound BAF for estimation of invertebrate tissue concentrations was replaced with the median value, no LOAEL HQs greater than 1 for the deer mouse (insectivore) were calculated. Similarly, when the TRVs from Sample et al. (1996) were used instead of the PRC TRVs, no HQs greater than 1 were calculated using either the NOAEL or the LOAEL TRV. The HQs were less than 1 whether the upper-bound or median BAF were used. These calculations indicate that while risks to the deer mouse (insectivore) may be greater than those predicted to the other receptors, they are over-predicted using the default input parameters provided in the CRA Methodology. The lack of elevated HQs when less conservative, yet still reasonable alternative values were used lends support to this conclusion. Therefore, risks to the deer mouse (insectivore) are likely to be low.

Non-PMJM Receptors – Large Home-Range

NOAEL HQs were greater than 1 for the coyote (generalist and insectivore) under the default exposure/TRV scenarios (Table 10.1). LOAEL HQs for both receptors were less than or equal to 1 for all exposure scenarios.

The uncertainty analysis discussed uncertainties and conservatisms related to both upper-bound BAFs used in the intake estimates and in the TRVs used to calculate HQs. However, because risks are classified as low using the more conservative default HQ calculations, no alternative HQs were calculated and risks are likely to be low to populations of all large home-range receptors from exposure to nickel in the LWOEU.

PMJM Receptor

Nickel was identified as an ECOPC for the PMJM receptor in Patches #22, #23, #24, and #27. Sample locations within PMJM habitat and a comparison to the ESL are shown in Figure 8.5. HQs greater than 1 were calculated using the NOAEL TRV. Upper-bound HQs range from 28 in Patch #24 to 85 in Patch #27. LOAEL HQs ranging from 3 to 9 were also calculated in each patch, indicating a potential for significant effects when using the default HQs. However, as discussed in the uncertainty analysis, the default exposure model and TRV resulted in significant risks calculated at the low end of the range of background concentrations.

The default LOAEL for nickel was selected from the same study and predicts an increase in pup mortality, but only at intake rates that would result in a back-calculated soil concentration (4.8 mg/kg) that is equal to the minimum detection in background surface soils. Risks calculated using the background UTL/UCL as EPCs indicate potentially significant levels of risk, with the NOAEL HQ equal to 27 and 20 for the UTL and UCL, respectively. LOAEL HQs equaled 3 and 2 for the same EPCs. Because risks are not generally expected in normal background concentrations, the uncertainty analysis recommended several steps to provide a less uncertain assessment of risks. These results indicate that further evaluation of risks to PMJM is necessary.

The alternative NOAEL TRV, discussed in the uncertainty analysis (Sample et al. 1996), is protective of body weight in neonate rats and provides a reasonable alternative no-effect level for PMJM. The LOAEL was derived from the same study and is predictive of a significant reduction in neonate rat body weights.

No LOAEL HQs greater than 1 were calculated in any patch for the PMJM using the median soil-to-invertebrate BAF and the default LOAEL TRV. Similarly, no HQs (NOAEL or LOAEL) were calculated using the upper-bound soil-to-invertebrate BAF or using either the alternative NOAEL or LOAEL TRVs.

Overall, risks to PMJM receptors in the LWOEU do not appear to be greatly elevated above those predicted in background concentrations. The combined lines of evidence indicate that site-related risks to the PMJM receptor are likely to be low in Patch #24 because HQs calculated in those patches are the same as those calculated using background data. Risks may be somewhat higher in Patches #22, #23, and #27. Alternative, exposure models, and TRVs indicate that risks may be much lower in all patches. Risks in all patches are, therefore, likely to range from low to potentially significant but may be overestimated based on results of HQ calculations using median BAFs and alternative TRVs.

10.1.5 Selenium

Selenium HQs for the PMJM receptor in Patch #23 are presented in Table 10.2. Selenium was not identified as an ECOPC in any other LWOEU PMJM habitat patch. Selenium was also not identified as an ECOPC for non-PMJM receptors.

HQs Calculated to Characterize Uncertainty

Uncertainties related to the default HQ calculations provided in Table 10.1 are discussed in detail in Attachment 5. Uncertainties related to BAFs, TRVs, and background risks are presented.

No HQs greater than 1 were calculated for the PMJM receptor in Patch #23 using the default assumptions. Therefore, no alternative HQ calculations are provided.

26

However, care should be taken to review the chemical-specific uncertainties discussed in Attachment 5 when reviewing the results of all receptors regardless of whether alternative HQs are provided.

PMJM Receptor

Selenium was identified as an ECOPC for the PMJM receptor in Patch #23 only. Sample locations within PMJM habitat and a comparison to the ESL are shown in Figure 8.6. No NOAEL or LOAEL HQs greater than 1 were calculated in Patch #23 using the UCL EPC. This indicates that risks are likely to be low for PMJM receptors in the LWOEU from exposure to selenium.

No alternative HQ calculations were provided because risks to the PMJM receptor are likely to be low based on the most conservative HQ calculations.

10.1.6 Thallium

Thallium HQs for terrestrial plants are presented in Table 10.1. Figure 10.5 shows the spatial distribution of thallium in relation to the terrestrial plant ESL and also presents the data used in the calculation of Tier 2 EPCs.

HQs Calculated to Characterize Uncertainty

Uncertainties related to the default HQ calculations provided in Table 10.1 are discussed in detail in Attachment 5. Uncertainties related to BAFs, TRVs, and background risks are presented.

The terrestrial plant receptors had an NOEC HQ greater than 1 (HQ = 2). No LOEC TRV was available, therefore, it is unclear whether risks are low or potentially significant using only the default ESL. The uncertainty analysis did not identify any alternative toxicity information. Therefore, no alterative HQs were calculated.

Thallium – Risk Description

Thallium was identified as an ECOPC for terrestrial plants only. Information on the historical use and a summary of site data and background data are provided in Attachment 3.

Terrestrial Plants

NOEC HQs were equal to 2 using Tier 1 UTL, but were less than 1 when using the Tier 2 UTL. The low HQs combined with the uncertain nature of the ESL discussed in the uncertainty analysis and the lack of known releases indicate that risks to populations of terrestrial plants from thallium in surface soils is low.

10.1.7 Tin

Tin HQs for the American kestrel, mourning dove (herbivore and insectivore), and deer mouse (insectivore) are presented in Table 10.1. Figure 10.6 shows the spatial distribution of tin in relation to the lowest ESL and also presents the data used in the calculation of the Tier 2 EPCs. Patch-specific HQs for the PMJM receptor (Patches #23, and #25) are presented in Table 10.2.

HQs Calculated to Characterize Uncertainty

Uncertainties related to the default HQ calculations provided in Table 10.1 are discussed in detail in Attachment 5. Uncertainties related to BAFs, TRVs, and background risks are presented.

No alternative BAFs or TRVs were recommended in the uncertainty analysis. Therefore, no HQs based on alternative assumptions are provided in Table 10.1 or 10.2.

However, care should be taken to review the chemical-specific uncertainties discussed in Attachment 5 when reviewing the results of all receptors regardless of whether alternative HQs are provided.

Tin – Risk Description

Tin was identified as an ECOPC for the American kestrel, mourning dove (herbivore and insectivore), deer mouse (insectivore), and PMJM receptors. Information on the historical use and a summary of site data and background data are provided in Attachment 3.

Non-PMJM Receptors – Small Home-Range

For the non-PMJM receptors, potential risks from exposure to tin were evaluated using Tier 1 and Tier 2 UTLs. NOAEL HQs were less than or equal to 1 for the mourning dove (herbivore). NOAEL HQs were greater than 1 for the mourning dove (insectivore), American kestrel, and deer mouse (insectivore). All LOAEL HQs for all receptors were less than 1. The lack of HQs calculated when using effects-based TRVs indicates that risk to non-PMJM small home-range receptors is low.

Table 10.3 presents a summary of HQs calculated using the arithmetic mean concentration used as cell-specific EPCs for surface soil samples within each of the Tier 2 30-acre grid cells. Default NOAEL and LOAEL TRVs were used in the HQ calculations. Tin samples were available from 23 grid cells (Figure 10.6). NOAEL HQs greater than 1 were calculated in 56 percent of the grid cells while no LOAEL HQs greater than 1 were calculated in any grid cell for the most sensitive receptor (mourning dove [insectivore]). The results of the grid-cell analysis indicate that the average exposure to sub-populations of small home-range receptors result in low risk from exposure to tin.

The uncertainty Section discussed the uncertainties and likely conservatisms in the BAFs used to estimate tissue concentrations. Because no HQs greater than 1 were calculated using the LOAEL TRV and because risks may be overestimated due to uncertainties in the BAFs used, risks to non-PMJM receptor populations in the LWOEU are likely to be low.

PMJM Receptor

Tin was identified as an ECOPC for the PMJM receptor in Patches #23 and #25 only. Sample locations within PMJM habitat and a comparison to the ESL are shown in Figure 8.7. Results of the PMJM risk calculations indicate that NOAEL HQs were greater than 1 in Patch #25 and less than 1 in Patch #23 using the UCL EPC (Table 10.2).

21

All LOAEL HQs were less than or equal to 1 in both patches.

As discussed in the uncertainty section, the default NOAEL is protective of systemic effects in mammals, which may or may not be predictive of reproductive or growth effects, thus indicating that the predictive value of the TRV may be low. However, the LOAEL TRV used in the risk estimation is based on an appropriate effect for the endpoints used in the CRA. This indicates that the NOAEL TRV is likely to be overly conservative, but the LOAEL may provide an accurate indicator of effects.

Because no LOAEL HQs greater than 1 were calculated and the BAFs used to estimate food tissue concentrations may overestimate risk, risks to the PMJM receptor in the LWOEU are likely to be low.

10.1.8 Vanadium

Vanadium HQs for terrestrial plants and the deer mouse (insectivore) are presented in Table 10.1. Figure 10.7 shows the spatial distribution of vanadium in relation to the lowest ESL and also presents the data used in the calculation of the Tier 2 EPCs. Patch-specific HQs for the PMJM receptor (Patches #22 and #23) are presented in Table 10.2.

HQs Calculated to Characterize Uncertainty

Uncertainties related to the default HQ calculations provided in Table 10.1 are discussed in detail in Attachment 5. Uncertainties related to BAFs, TRVs, and background risks are presented.

For the terrestrial plant, HQs calculated using the default NOEC ESL were greater than 1. However, no LOEC TRV was available making it impossible to classify potential risk. The uncertainty analysis provided an alternative LOEC. HQs calculated using the alternative LOEC TRV are presented in Table 10.1.

For other non-PMJM receptors, no receptors had LOAEL HQs greater than 1 using the default exposure assumptions, and no alternative HQs were calculated. For PMJM receptors, no NOAEL or LOAEL HQs greater than 1 were calculated in Patch #23 using the default HQ calculations. Therefore, no alternative HQs were calculated.

However, care should be taken to review the chemical-specific uncertainties discussed in Attachment 5 when reviewing the results of all receptors regardless of whether alternative HQs are provided.

Vanadium – Risk Description

Vanadium was identified as an ECOPC for terrestrial plants as well as the deer mouse (insectivore) and PMJM receptors. Information on the historical use and a summary of site data and background data are provided in Attachment 3.

Terrestrial Plants

For terrestrial plants, the default HQ was greater than 1 using the ESL. This indicates that potential risk cannot be ruled out using the default NOEC ESL. However, because no

LOEC value was available, it is uncertain whether risk is possible or not using the default values.

The uncertainty assessment recommended the use of an alternative LOEC value (50 mg/kg). The Tier 1 UTL concentration results in an HQ equal to 1, while the Tier 2 UTL results in an HQ less than 1, indicating that risks to terrestrial plant populations are likely to be low.

The uncertainty analysis also presented a discussion of background risks predicted by the default ESL. The default ESL (2 mg/kg) is less than all site-specific background concentrations. HQs greater than 1 were calculated using UTL and UCL background concentrations (HQ = 23 and 15 respectively). An HQ equal to 5 would be calculated using the minimum background concentration and the default ESL.

No HQs greater than 1 were calculated using the alternative LOEC value. This coupled with the low confidence placed in the ESL and the comparison of the ESL to background concentrations supports the conclusion that risks to populations of plants from exposure to vanadium in surface soils are likely to be low.

Non-PMJM Receptors – Small Home-Range

For non-PMJM receptors, Tier 1 EPCs resulted in NOAEL HQs greater than (Tier 1 UTL HQ = 2) or equal to 1 for the deer mouse (insectivore). NOAEL HQs were equal to 1 using the Tier 2 UTL. All LOAEL HQs were less than 1. Because no HQs greater than 1 were calculated using an effects-based TRV, risks are likely to be low from exposure to vanadium.

Table 10.3 presents a summary of HQs calculated using the arithmetic mean concentration used as cell-specific EPCs for surface soil samples within each of the Tier 2 30-acre grid cells. Default NOAEL and LOAEL TRVs were used in the HQ calculations. Vanadium samples were available from 26 grid cells (Figure 10.7). NOAEL HQs greater than 1 were calculated in 62 percent of the grid cells while no grid cell had an LOAEL HQ greater than 1 for the most sensitive receptor (deer mouse [insectivore]). The results of the grid-cell analysis indicate that the average exposure to sub-populations of small home-range receptors results in low risk from exposure to vanadium.

Because no HQs greater than 1 were calculated using the LOAEL TRV using the default exposure model and TRVs, risks to non-PMJM receptor populations in the LWOEU are likely to be low.

PMJM Receptors

For the PMJM receptor, NOAEL HQs were greater than 1 in Patches #22 and #23 for both the Tier 1 and Tier 2 EPCs (Table 10.2). Figure 8.8 presents vanadium sampling locations and a comparison to the PMJM ESL. Vanadium was not identified as an ECOPC for Patches #24 and #27.

NOAEL HQs were less than 3 in both Patches #22 and #23 when using the UCL as the EPC. No LOAEL HQs in either patch were greater than 1. These results indicate that

28

risks to PMJM from exposure to vanadium are likely to be low in all patches. No HQs greater than any effect-based TRV were calculated.

As indicated in the uncertainty analysis, the conservative nature of the upper-bound BAFs used to estimate plant and invertebrate tissue concentrations may overestimate risk. However, because no NOAEL HQs greater than 3 or LOAEL HQs greater than 1 were calculated using the most conservative exposure models, risks are likely to be low and no additional HQs were calculated.

HQs were calculated in the uncertainty analysis using the same NOAEL and LOAEL TRVs but with median BAFs. NOAEL HQs greater than 1 were calculated in both Patch #22 and #23 using the MDC (HQ = 2). No LOAEL HQs greater than 1 were calculated for any patch when the median BAFs were applied to the intake calculations.

Because no HQs greater than 1 using the LOAEL TRV with even the upper-bound BAFs, and risks were not generally higher than those calculated using background surface soil EPCs, risks to PMJM receptors from vanadium are likely low in all the LWOEU habitat patches.

10.1.9 Zinc

Zinc HQs for the PMJM receptor in Patches #23 and #27 are presented in Table 10.2. Zinc was not identified as an ECOPC in any other LWOEU PMJM habitat patch. Zinc was also not identified as an ECOPC for non-PMJM receptors.

HQs Calculated to Characterize Uncertainty

Uncertainties related to the default HQ calculations provided in Table 10.1 are discussed in detail in Attachment 5. Uncertainties related to BAFs, TRVs, and background risks are presented.

No NOAEL HQs greater than 3 were calculated for the PMJM receptor in either patch using the default assumptions. Therefore, no alternative HQ calculations are provided.

However, care should be taken to review the chemical-specific uncertainties discussed in Attachment 5 when reviewing the results of all receptors regardless of whether alternative HQs are provided.

PMJM Receptor

Zinc was identified as an ECOPC for the PMJM receptor in Patches #23 and #27 only. Sample locations within PMJM habitat and a comparison to the ESL are shown in Figure 8.9. In Patch #23, the NOAEL HQ using the UCL equaled 2. In Patch #27, the NOAEL HQ using the UCL equaled 3. No LOAEL HQs greater than 1 were calculated in either patch using the UCL EPC. This indicates that risks are likely to be low for PMJM receptors in the LWOEU from exposure to zinc.

No alternative HQ calculations were provided because risks to the PMJM receptor are likely to be low based on the most conservative HQ calculations.

10.2 Ecosystem Characterization

An ecological monitoring program has been underway since 1991 when baseline data on wildlife species was gathered (Ebasco 1992). The purpose of this long-term program was to monitor specific habitats to provide a sitewide database from which to monitor trends in the wildlife populations at RFETS. This type of monitoring program provides localized information, which can also be used for analysis at a landscape level, to monitor the population trends and general health of the RFETS ecosystem. Permanent transects through three basic habitats were run monthly for over a decade (K-H 2002). Observations concerning the abundance, distribution, and diversity of wide-ranging wildlife species were recorded including observations of migratory birds, raptors, coyotes, and deer.

Migratory birds were tracked during all seasons but most notably during the breeding season. Over 8 years of bird survey data were collected on 18 permanent transects. Field observations were summarized into species richness and densities by habitat type. Habitats comprised the general categories of grasslands, woodlands, and wetlands. LWOEU contributed to the overall summaries with one permanent transect in shrublands within its boundaries. However, summaries in annual reports are grouped by habitat types across RFETS, not within EUs, as EU boundaries were determined well after the monitoring program had begun. Additionally, wide-ranging animals may use habitat in several EUs and do not recognize EU boundaries.

Summarizing songbird surveys over the breeding season, diversity indices for RFETS for all habitats combined over 8 years of observations (1991 and 1993 to 1999) show a steady state in diversity of bird communities (K-H 2000). Among habitats, results were similar within grassland and wetland habitats, but riparian woodlands, which include shrublands, revealed a slight decrease (K-H 2000). However, this trend can be mostly attributed to transient species (i.e., those species not usually associated with woody cover) except for red-tailed hawk (*Buteo jamaicensis*) and American goldfinch (Carduelis *tristis*). The red-tailed hawk change in density can be attributed to a loss of a nesting site in Upper Woman Creek, not Lower Woman Creek. Goldfinch abundance can be heavily influenced by the availability of food sources and their slight decline is not of monitoring concern.

A subgroup of migratory birds is neotropical migrants which are in a decline in North America (Audubon 2005-see website). Most of this decline is thought to be due to conversion of forest land to agriculture in the tropics and to real estate development in North America. Grassland birds that are neotropical migrants are also in decline. However, over the last 5 years the declining trends on RFETS have not been observed as densities and for this group have been increasing.

Raptors, big game species, and carnivores were observed through relative abundance surveys and multi-species surveys (16 permanent transects) that provided species-specific sitewide counts. Raptors were noted on relative abundance surveys and nest sites were visited repeatedly during the nesting season to confirm nesting success. The three most common raptors on RFETS are the red-tailed hawk, great horned owl (*Bubo virginianus*),

29

and American kestrel (*Falco sparverius*) (K-H 2002). Typically in Lower Woman Creek, there is one great horned owl nest and several American kestrel nests (Ryon 2005). Owl nests on site typically fledge two young per nest ,and kestrels usually fledge two to three young. Each species had a successful nesting season each year during the monitoring period from 1991 to 1999 (K-H 1997, 1998, 1999). The continued presence of nesting raptors at RFETS (K-H 2002) including the LWOEU, indicate that habitat quality and protection from human disturbance have contributed to making RFETS a desirable location for raptors to reproduce. Adequate habitat provides essential seasonal requirements. RFETS is estimated to be at optimum population density for raptors given available habitat and the territorial nature of these species (K-H 2000).

Two deer species inhabit RFETS, mule deer (*Odocoileus hemionus*) and white-tail deer (*Odocoileus virginianus*). No white-tail deer were present at RFETS in 1991 when monitoring began (K-H 2002). In 2000 (K-H 2001) numbers of white-tail deer were estimated between 10 and 15 individuals spending the majority of their time in the LWOEU. Mule deer frequent all parts of RFETS (14 mi^2) year-round. The RFETS population from winter counts is estimated at a mean 125 individuals ($n = 7$) with a density of 14 deer per square mile (K-H 2000, 2002). Winter mule deer counts have varied from 100 to 160 individuals over the monitoring period (1994 to 2000) with expected age/sex class distributions (K-H 2001). Obviously, the population at RFETS is "open" with individuals able to move freely on an off site. In comparison, mule deer populations at the Rocky Mountain Arsenal (27 mi^2) are estimated between 175 to 213 individuals based on ground observations (Whittaker 1995). This equates to a density of 93.6 km^2 (36.1mi^2), a much denser population. The number of mule deer at the Rocky Mountain Arsenal increased substantially toward the end of the study. The U.S. Army had erected a chain-link fence around the site in the early 1990s (Skipper 2005) and effectively closed the population thus negating any immigration. Prior to the fence being installed, mule deer densities were estimated at 44.3 km^2 (17 mi^2), similar to what has been observed at RFETS. The mule deer populations from RFETS has been at a steady state with good age/sex distributions (K-H 2001) over time and similar densities compared to other "open" populations that are not hunted. This provides a good indicator that habitat quality is high across the site including the LWOEU and that site activities have not affected deer populations. It is unlikely that deer populations are depressed or reproduction is affected by contaminants. A recent study on actinides in deer tissue found that plutonium levels were near or below detection limits (Todd and Sattelberg 2004). This provides further support that deer population is healthy.

Coyotes (*Canis latrans*) are the top mammalian predator at RFETS. They prey upon mule deer fawns and other smaller prey species. The number of coyotes using the site has been estimated at 14 to 16 individuals (K-H 2002). Through surveys across the site, coyotes have been observed having reproduction success with as many as six dens active in 1 year (Nelson 2003). Typically at RFETS, three to six coyote dens support an estimated 14 to 16 individuals at any given time (K-H, 2001). LWOEU typically does not support coyote dens but does support important hunting habitat for coyotes. Coyotes have been observed hunting deer in the LWOEU in winter on numerous occasions (Ryon 2005). Coyotes have exhibited a steady population over time, which indicates their prey species continue to be abundant and healthy.

Small mammal trapping has occurred over several years as a component of the ecological monitoring program, especially during studies of the PMJM. The LWOEU has been trapped over several years (K-H 1998, K-H 2001). Although no PMJM have ever been captured in the LWOEU, typical small mammal species, as listed in the Flora and Fauna of LWOEU (Section 1.1.3.), are present. Additionally, less common species include pocket mouse species such as hispid pocket mouse (*Chaetodipus hispidus*) found in riparian areas and plains pocket mouse (*Perognathus flavescens*) found in grasslands (Ryon 2005). The existence of both species are an indication of diverse and healthy small mammal communities, and monitoring has revealed abundance and species diversity that would be expected in typical native ecosystems on the plains of Colorado (Fitzgerald et al 1994).

The high species diversity and continued use of the site by numerous vertebrate species verifies that habitat quality for these species remains acceptable and the ecosystem functions are being maintained (K-H 2000). Data collected on wildlife abundance and diversity indicate that wildlife populations are stable and species richness remains high during remediation activities at RFETS including wildlife using LWOEU.

10.3 General Uncertainty Analysis

Quantitative evaluation of ecological risks is limited by uncertainties regarding the assumptions used to predict risk and the data available for quantifying risk. These limitations are usually circumvented by making estimates based on the data available or by making assumptions based on professional judgment when data are limited. Because of these assumptions and estimates, the results of the risk calculations themselves are uncertain, and it is important for risk managers and the public to view the results of the risk assessment with this in mind. A full discussion of categories of general uncertainty that are not specific to the LWOEU are presented in Appendix A, Volume 2 of the RI/FS Report. The following sections are potential sources of general uncertainty that are specific to the LWOEU ERA. Chemical-specific uncertainties are presented in Attachment 5 of this document and were discussed in terms of the potential effects on the risk characterization in the risk description Section for each ECOPC.

10.3.1 Uncertainties Associated with Data Adequacy and Quality

Sections 1.2 and 1.3 summarize the general data adequacy and data quality for the LWOEU, respectively. A more detailed discussion is presented in Attachment 2 and Appendix A, Volume 2 of the RI/FS. The data adequacy assessment indicates that the data are adequate for the CRA. Data of sufficient quality for ERA purposes were collected in surface and subsurface soils.

10.3.2 Uncertainties Associated with the Lack of Toxicity Data for Ecological Contaminant of Interest Detected at the Lower Woman Drainage Exposure Unit

Several ECOIs detected in the LWOEU do not have adequate toxicity data for the derivation of ESLs (CRA Methodology [DOE 2004a]). These ECOIs are listed in

30

Tables 7.1, 7.3, and 7.12 with a "UT" designation. Appendix B of the CRA Methodology outlines a detailed search process that was intended to provide high-quality toxicological information for a large proportion of the chemicals detected at RFETS. Although the toxicity is uncertain for those ECOIs that do not have ESLs calculated due to a lack of identified toxicity data, the overall effect on the risk assessment is small because the primary chemicals historically used at RFETS have adequate toxicity data for use in the CRA. Therefore, while the potential for risk from these ECOPCs is uncertain and will tend to underestimate the overall risk calculated, the magnitude of underestimation is likely to be low.

ESLs and/or TRVs were not available for several of the ECOPC/receptor pairs identified in Section 7. These include manganese (invertebrates), thallium (invertebrates), tin (invertebrates), and vanadium (invertebrates). The risks to these ECOPC/receptor pairs is uncertain. However, because risks to all of the ECOPCs mentioned above is considered to be low for those receptors where toxicity information is available, this source of uncertainty is not expected to be significant.

10.3.3 Uncertainties Associated with Eliminating Ecological Contaminants of Interest Based on Professional Judgment

Several analytes in surface soil and subsurface soil were eliminated as ECOIs based on professional judgment. The professional judgment evaluation is intended to identify those ECOIs that have a limited potential for contamination in the LWOEU. The weight-of-evidence approach supports the conclusion that there is no identified source or pattern of release in the LWOEU, and the slightly elevated values of the LWOEU data for these ECOIs are most likely due to natural variation. The professional judgment evaluation has little effect on the overall risk calculations because the ECOIs eliminated from further consideration are not related to site activities in the LWOEU and have very low potential to be transported from historical sources to the LWOEU.

10.4 Summary of Significant Sources of Uncertainty

The preceding discussion outlined the significant sources of uncertainty in the CRA process for assessing ecological risk. While some of the general sources of uncertainty discussed tend to underestimate risk, an equal or greater number of uncertainties discussed for each ECOPC and in Appendix A, Volume 2 of the RI/FS Report indicate that risk estimations may be somewhat biased toward the overestimation of risk to a generally unknown degree. The full range of potential effects of uncertainties on the results of the ERA should be considered when reviewing the results of the risk assessment.

11.0 SUMMARY AND CONCLUSIONS

A summary of the results of this CRA for human health and ecological receptors in the LWOEU is presented below.

11.1 Human Health

The COC screening analyses compared MDCs and UCLs of chemicals and radionuclides in LWOEU media to PRGs for the WRW receptor. Inorganic and radionuclide analytes with UCLs greater than the PRGs were statistically compared to the background concentration data set. Inorganic and radionuclide analytes that were statistically greater than background at the 0.1 significance level, and organics with UCL concentrations greater than the PRG were carried forward to professional judgment evaluation. Based on the COC selection process, no COCs were selected for surface soil/surface sediment or subsurface soil/subsurface sediment in the LWOEU and a risk characterization was not performed for the LWOEU.

11.2 Ecological Risk

Low risk to survival, growth, and reproduction is predicted for the ecological receptors evaluated in the LWOEU (see Table 11.1). ECOPCs in surface soil were identified for non-PMJM and PMJM receptors. ECOPCs for selected populations of non-PMJM receptors included chromium, copper, manganese, nickel, thallium, tin, and vanadium. ECOPCs for individual PMJM receptors included chromium, copper, manganese, nickel, selenium, tin, vanadium, and zinc. No ECOPCs were identified in subsurface soil. The ECOPC/receptor pairs were evaluated in the risk characterization using a range of EPCs, exposure scenarios, and TRVs to give a range of risk estimates. Overall, no significant risks to ecological receptors that may use the LWOEU are predicted.

In addition, the high species diversity and continued use of the site by numerous vertebrate species verify that habitat quality for these species remains acceptable and the ecosystem functions are being maintained (K-H 2000). Data collected on wildlife abundance and diversity indicate that wildlife populations are stable and species richness remains high during remediation activities at RFETS, including wildlife using the LWOEU.

12.0 REFERENCES

Audubon, 2005. The Missing Birds of Rock Creek Park. Online article under Issues and Actions. Web address [http://www.audubon.org/campaign/population_habitat]. Accessed July 2005.

DOE, 1992. Final Historical Release Report for Rocky Flats Plant, Golden, Colorado. June.

DOE, 1995. Final Letter Report – Colorado Department of Public Health and Environment Source Area Delineation and Risk-Based Conservative Screen and Environmental Protection Agency Area of Concern Delineation. Rocky Flats Environmental Technology Site OU 11, West Spray Field, Golden, Colorado. June.

DOE, 2002. Final Buffer Zone Sampling and Analysis Plan, Rocky Flats Environmental Technology Site, Golden, Colorado. June.

31

DOE, 2004. Comprehensive Risk Assessment Sampling and Analysis Plan Addendum, #04-01, Rocky Flats Environmental Technology Site, Golden, Colorado. March.

DOE, 2005a. Final Comprehensive Risk Assessment Work Plan and Methodology, Rocky Flats Environmental Technology Site, Golden, Colorado. Revision 1. September.

DOE, 2005b. 2005 Annual Update to the Historical Release Report, Rocky Flats Environmental Technology Site, Golden, Colorado.

Ebasco Environmental Consultants Inc., 1992. Baseline Biological Characterization of the Terrestrial and Aquatic Habitats at Rocky Flats Plant. Prepared for U.S. DOE, Rocky Flats Field Office. Golden, Colorado.

EPA, CDPHE, and DOE, 2002. Task 3 Report and Appendices: Calculation of Surface Radionuclide Soil Action Levels for Plutonium, Americium, and Uranium, Rocky Flats Environmental Technology Site, , et al. 2002.

Fitzgerald, J.P., CA, Meaney and D.M. Armstrong, 1994. Mammals of Colorado. University Press of Colorado and Denver. Museum of Natural History. 467 pp.

Interagency Agreement (IAG), 1991. Federal Facility Agreement and Consent Order CERCLA VIII-91-03, RCRA (3008(h)) VIII-91-07 and State of Colorado Docket number 91-01-22-01.

K-H, 1997. 1996 Annual Wildlife Survey for the Rocky Flats Environmental Technology Site. Kaiser-Hill Company, L.L.C., Rocky Flats Environmental Technology Site, Golden, Colorado.

K-H, 1998. 1997 Annual Wildlife Survey for the Rocky Flats Environmental Technology Site. Kaiser-Hill Company, L.L.C., Rocky Flats Environmental Technology Site, Golden, Colorado.

K-H, 1999a. 1998 Annual Wildlife Survey for the Rocky Flats Environmental Technology Site. Kaiser-Hill Company, L.L.C., Rocky Flats Environmental Technology Site, Golden, Colorado.

K-H, 2000. 1999 Annual Wildlife Survey for the Rocky Flats Environmental Technology Site. Kaiser-Hill Company, L.L.C., Rocky Flats Environmental Technology Site, Golden, Colorado.

K-H, 2001. 2000 Annual Wildlife Survey Report for the Rocky Flats Environmental Technology Site, Kaiser-Hill Company, L.L.C., Rocky Flats Environmental Technology Site, Golden, Colorado.

K-H, 2002. 2001 Annual Wildlife Survey Report for the Rocky Flats Environmental Technology Site, Kaiser-Hill Company, L.L.C., Rocky Flats Environmental Technology Site, Golden, Colorado.

Nelson, J., 2003, Senior Ecologist, Kaiser-Hill Ecology Group. Rocky Flats Environmental Technology Site. Personal communication with Bill Mengle, ERO Resources. January 14.

Rocky Flats Cleanup Agreement (RFCA), 1996. CERCLA Federal Facility Agreement and RCRA/CHWA Consent Order (CERCLA VIII-96-21; RCRA (3008(h)) VIII-96-01; State of Colorado Docket #96-07-19-0).

Ryon, T., 2005. Senior Biologist, OtterTail Environmental, Inc. Former Rocky Flats Environmental Technology Site Wildlife Biologist. Personal Communication with Joe Allen, Senior Risk Assessor, Newfields. June 2005.

Sample, B.E., D.M. Opresko, and G.W Suter, II, 1996. Toxicological Benchmarks for Wildlife: 1996 Revision. ES/ER/TM-86/R3. Oak Ridge National Laboratory, Oak Ridge, Tennessee. 227 pp.

Shacklette, H.T., and J.G. Boerngen, 1984. Element Concentrations in Soils and Other Surface Materials of the Contiguous United States. Professional Paper 1270. U.S. Geological Survey, Washington, D.C.

Skipper, 2005. Wildlife Biologist, U.S. Fish and Wildlife Service, Rocky Mountain Arsenal. Personal Communication with Thomas Ryon, Senior Biologist, OtterTail Environmental, Inc. July 2005.

Todd, A., and M. Sattelberg, 2004. Actinides in Deer Tissue at the Rocky Flats Environmental Technology Site. U.S. Fish and Wildlife Service Internal Report.

USFWS, 2004. Rocky Flats National Wildlife Refuge, Final Comprehensive Conservation Plan and Environmental Impact Statement. U.S. Fish and Wildlife Service. September.

Whittaker, D.G., 1995. Patterns of Coexistence for Sympatric Mule and White-Tailed Deer on Rocky Mountain Arsenal, Colorado. Ph.D. Dissertation, University of Wyoming, Laramie, Wyoming. 103 pp., Tables, and Figures.

32

TABLES

33

Table 1.1
LWOEU IHSSs

IHSS	OU	PAC	Title	Description	Disposition
--	BZ	000-501	Roadway Spraying	Roadways in the BZ OU were sprayed with waste oils for dust suppression; reverse osmosis brine solutions and footing drain water were also applied.[a]	NFA -2005 HRR
--	BZ	SE-1602	East Firing Range	The East Firing Range (PAC SE-1602) included two target areas where handgun, shotgun, and rifle bullets of various caliber, as well as depleted uranium armor-piercing bullets were fired into the hillside or into soil berms, potentially releasing lead into the soil.	NFA -2005 HRR[b]
142.10	BZ	SE-142.10	Pond C-1	Water from Woman Creek flows into and through Pond C-1. Outflow from C-1 is diverted around Pond C-2 and back into the Woman Creek channel or into Mower Ditch.	NFA -2005 HRR
142.11	BZ	SE-142.11	Pond C-2	Pond C-2 receives water from the South Interceptor Ditch, which intercepts water from the Industrial Area. Water in Pond C-2 is monitored prior to scheduled discharges.	NFA -2005 HRR
209	BZ	SE-209	Surface Disturbance Southeast of Bldg. 881	IHSS 209 is an area that has been disturbed by unknown activities. Three excavations were found in the 5.2-acre area.	NFA -2005 HRR

[a]PAC 000-501 was one of 79 IHSSs/PACs proposed for NFA by the NFA Working Group in 1991. The NFA was approved in 2002 (EPA et al. 2002).

[b] Closeout Report for IHSS Group 900-11, PAC SE-1602, East Firing Range, and Target Area was approved by EPA in a letter from C. Mark Aguilar to Joseph Legare dated February 8, 2005.

Table 1.2
Number of Samples in Each Medium by Analyte Suite

Analyte Suite	Surface Soil/Surface Sediment[a]	Subsurface Soil/Subsurface Sediment[a]	Surface Soil[b]	Surface Soil (PMJM)[b]	Subsurface Soil[b]
Inorganics	106	55	74	45	47
Organics	34	36	9	2	28
Radionuclides	144	31	98	41	20

[a] Used in the HHRA.

[b] Used in the ERA.

Note: The total number of results (samples) for the analytes listed in Tables 1.3 to 1.7 may differ from the number of samples presented in Table 1.2 because not all analyses are necessarily performed for each sample.

50

Table 1.3
Summary of Detected Analytes in Surface Soil/Surface Sediment

Analyte	Range of Reported Detection Limits	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration[a]	Standard Deviation[a]
Inorganics (mg/kg)							
Aluminum	4.1 - 50	106	100	1,990	31,000	14,428	6,497
Ammonia[b]	0.3 - 0.3	1	100	2.05	2.05	2.05	N/A
Antimony	0.29 - 50	91	33.0	0.300	9.80	2.23	2.84
Arsenic	0.18 - 3	106	100	1.50	9.80	5.60	1.77
Barium	0.14 - 40	106	100	26.6	330	151	53.4
Beryllium	0.1 - 5	105	86.7	0.180	6.70	0.850	0.656
Boron	1 - 2.3	56	94.6	2.30	14	7.30	2.28
Cadmium	0.028 - 5	104	49.0	0.110	1.80	0.436	0.281
Calcium	4.2 - 1,000	106	100	1,300	47,700	7,105	7,317
Cesium[b]	107 - 500	33	21.2	1.70	7	32.5	32.3
Chromium	0.15 - 10	106	100	3.30	30	15.8	6.48
Cobalt	0.11 - 10	106	100	1.60	20.2	8.02	2.42
Copper	0.046 - 10	106	98.1	7.60	170	18.8	16.1
Iron	1.4 - 20	106	100	4,320	38,000	17,697	5,720
Lead	0.27 - 3.1	106	100	6.40	210	42.1	38.3
Lithium	0.34 - 20	90	91.1	1.80	28	11.8	5.31
Magnesium	4.2 - 1,000	106	100	523	5,800	3,023	1,088
Manganese	0.089 - 10	106	100	106	1,580	388	208
Mercury	0.0052 - 0.2	90	53.3	0.0130	0.680	0.0711	0.130
Molybdenum	0.3 - 40	90	62.2	0.370	5.40	1.17	1.03
Nickel	0.2 - 20	106	95.3	5.30	45.2	15.4	5.90
Nitrate / Nitrite	0.2 - 2.4	23	78.3	0.611	26.6	3.91	6.20
Potassium	36 - 1,000	106	96.2	401	5,160	2,672	1,039
Selenium	0.2 - 2.1	105	35.2	0.260	2.80	0.549	0.438
Silica[b]	4.4 - 11	56	100	560	1,600	1,016	211
Silicon[b]	0 - 100	20	100	145	2,000	653	615
Silver	0.079 - 10	97	6.19	0.150	1.70	0.376	0.422
Sodium	10.2 - 1,000	106	44.3	47.8	643	110	89.6
Strontium	0.059 - 400	92	100	9.70	167	47.6	25.2
Thallium	0.28 - 2	105	38.1	0.250	10	0.956	1.39
Tin	0.86 - 100	91	22.0	1.70	85.9	6.56	11.4
Titanium	0.089 - 0.33	56	100	53	360	192	69.9
Vanadium	0.47 - 10	106	100	6.90	71	37.2	12.6
Zinc	0.4 - 10	106	100	17.9	201	65.8	29.9
Organics (µg/kg)							
1,2,3,4,6,7,8-HpCDF	0.00271	1	100	8.07E-04	8.07E-04	8.07E-04	N/A
2,4-Dinitrophenol	220 - 4,100	29	3.45	890	890	1,822	1,033
2-Butanone	10 - 25	12	16.7	3	63	12.7	16.0
4,6-Dinitro-2-methylphenol	290 - 4,100	31	3.23	750	750	1,776	1,016
4-Methyl-2-pentanone	10 - 25	15	6.67	3	3	9.10	3.08
4-Methylphenol	26 - 820	31	6.45	93	200	364	225
Acenaphthene	31 - 820	31	6.45	74	320	325	180
Acetone[b]	10 - 25	15	13.3	18	66	29.8	32.2
Aldrin	8 - 99	28	3.57	0	0	9.78	9.25
alpha-Chlordane	16 - 990	28	3.57	0	0	97.8	92.5
Anthracene	31 - 820	31	12.9	90	450	330	181
Aroclor-1254	12 - 2,000	32	9.38	94	220	199	202
Benzo(a)anthracene	36 - 820	31	12.9	64	190	322	208
Benzo(a)pyrene	36 - 820	31	9.68	66	170	341	214
Benzo(b)fluoranthene	97 - 820	31	9.68	120	180	342	205
Benzo(g,h,i)perylene	29 - 820	31	3.23	150	150	360	211
Benzo(k)fluoranthene	73 - 820	31	6.45	110	150	358	214
Benzoic Acid	510 - 3,700	30	16.7	180	700	1,681	1,147
beta-BHC	8 - 99	28	3.57	0	0	9.78	9.25
bis(2-ethylhexyl)phthalate	57 - 820	31	41.9	64	2,200	422	425
Butylbenzylphthalate	78 - 820	31	3.23	57	57	372	222
Chrysene	49 - 820	31	16.1	42	190	317	212
delta-BHC	8 - 99	28	3.57	0	0	9.78	9.25
Dibenz(a,h)anthracene	35 - 820	31	3.23	530	530	372	209
Di-n-butylphthalate	53 - 820	31	9.68	45	70	360	234
Endosulfan I	8 - 190	28	3.57	0	0	9.78	9.25

36

Table 1.3
Summary of Detected Analytes in Surface Soil/Surface Sediment

Analyte	Range of Reported Detection Limits	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration[a]	Standard Deviation[a]
Fluoranthene	66 - 820	31	19.4	79	330	308	197
gamma-BHC (Lindane)	8 - 99	28	3.57	4.40	4.40	10.6	10.4
gamma-Chlordane	16 - 990	17	5.88	0	0	119	113
Heptachlor	8 - 99	28	3.57	0	0	9.78	9.25
Heptachlor epoxide	8 - 99	28	3.57	0	0	9.78	9.25
Heptachlorodibenzo-p-dioxin	0.00271	1	100	0.00509	0.00509	0.00509	N/A
Indeno(1,2,3-cd)pyrene	40 - 820	31	6.45	340	500	363	204
Methylene Chloride	5 - 12	15	13.3	12	16	11.1	7.68
OCDD	0.00542	1	100	0.0306	0.0306	0.0306	N/A
OCDF	0.00542	1	100	0.00128	0.00128	0.00128	N/A
Pentachlorophenol	200 - 4,100	31	3.23	950	950	1,782	1,009
Phenanthrene	31 - 820	31	19.4	46	360	322	184
Phenol	33 - 820	31	3.23	150	150	360	211
Pyrene	240 - 820	31	9.68	70	310	360	214
Toluene	5 - 12	16	31.3	2	410	75.4	149
Radionuclides (pCi/g)[c]							
Americium-241	0 - 0.287	131	N/A	-0.0153	1.66	0.265	0.306
Cesium-134	0.067 - 0.2	13	N/A	0.00200	0.200	0.0849	0.0520
Cesium-137	0.013 - 0.19	19	N/A	0.0391	1.18	0.349	0.315
Gross Alpha	1.8 - 56	29	N/A	-0.760	152	26.1	28.3
Gross Beta	1 - 21	29	N/A	8.02	45	28.6	10.5
Plutonium-238	0.0123 - 0.0293	6	N/A	0.00998	0.0601	0.0343	0.0198
Plutonium-239/240	0 - 0.182	140	N/A	-0.00192	12.2	1.58	1.98
Radium-226	0.12 - 0.5	10	N/A	0.985	2	1.30	0.310
Radium-228	0.07 - 0.61	9	N/A	1.19	2.80	1.94	0.519
Strontium-89/90	0.03 - 1.12	20	N/A	0.0300	3.24	0.636	0.932
Uranium-233/234	0 - 0.683	72	N/A	0.320	3.19	1.29	0.575
Uranium-235	0 - 0.602	72	N/A	-0.0562	0.405	0.0779	0.0789
Uranium-238	0 - 0.457	72	N/A	0.340	3.39	1.31	0.551

[a] For inorganics and organics, statistics are computed using one-half the reported value for nondetects.

[b] All detections are "J" qualified, signifying that the reported result is below the detection limit, but above the instrument detection limit.

[c] All radionuclide values are considered detects.

N/A = Not applicable.

37

Table 1.4
Summary of Detected Analytes in Subsurface Soil/Subsurface Sediment

Analyte	Range of Reported Detection Limits	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration	Standard Deviation
Inorganics (mg/kg)							
Aluminum	4.2 - 40	55	100	3,130	37,000	18,484	9,711
Antimony	0.27 - 12	53	30.2	0.300	20.2	2.29	3.85
Arsenic	0.23 - 2	55	100	1.60	15	5.81	2.46
Barium	0.13 - 40	55	100	34.6	270	155	59.6
Beryllium	0.026 - 1	55	100	0.230	1.60	0.984	0.354
Boron	0.97 - 2.1	35	97.1	2.30	11	7.14	2.01
Cadmium	0.027 - 1	52	65.4	0.0790	1.80	0.424	0.304
Calcium	1.3 - 1,000	55	100	1,170	98,200	9,079	16,257
Cesium[b]	84.9 - 200	17	29.4	0.860	2.65	16.5	21.4
Chromium	0.06 - 2	55	100	5.40	73.9	23.4	12.6
Cobalt	0.11 - 10	55	100	2.20	17.1	8.21	2.93
Copper	0.044 - 5	55	100	6.40	30	18.3	5.48
Iron	0.54 - 20	55	100	5,120	35,800	19,433	6,606
Lead	0.26 - 1.2	55	100	3.20	1,400	51.8	189
Lithium	0.29 - 20	55	100	2.80	26	13.9	6.67
Magnesium	3.7 - 1,000	55	100	874	6,570	3,624	1,510
Manganese	0.084 - 3	55	100	41	793	292	131
Mercury	0.0049 - 0.12	55	47.3	0.0120	1.80	0.122	0.355
Molybdenum	0.2 - 40	54	46.3	0.330	6.50	0.949	1.12
Nickel	0.19 - 8	55	100	5.20	49.9	18.6	7.31
Nitrate / Nitrite	0.2 - 0.2	6	100	0.700	1.30	1	0.253
Potassium	35 - 1,000	55	100	574	5,400	2,673	1,424
Selenium	0.28 - 1.9	54	14.8	0.270	1.50	0.445	0.273
Silica[b]	1.5 - 9.5	35	100	610	1,500	1,002	207
Silicon[b]	0	5	100	23.7	383	203	152
Silver	0.073 - 2	53	3.77	0.0940	0.120	0.188	0.195
Sodium	2.3 - 1,000	55	30.9	23.3	444	103	93.5
Strontium	0.057 - 400	55	100	10.9	401	58.6	62.7
Thallium	0.31 - 2	54	46.3	0.210	3.10	0.844	0.745
Tin	0.57 - 40	54	38.9	1	22.3	4.94	8.70
Titanium	0.085 - 0.3	35	100	41	370	197	80.4
Uranium	1.1 - 16	35	5.71	1.50	1.80	1.43	1.61
Vanadium	0.35 - 10	55	100	14	110	42.9	18.6
Zinc	0.38 - 4	55	100	18	110	57.7	20.5
Organics (µg/kg)							
1,2,3,4,6,7,8-HpCDF	0.00147 - 0.00226	3	66.7	8.32E-04	0.00158	0.00106	4.51E-04
1,2,3,4,7,8-HxCDF	0.00147 - 0.00226	3	33.3	0.00127	0.00127	9.25E-04	2.99E-04
1,2,3,6,7,8-HxCDF	0.00147 - 0.00226	3	33.3	5.62E-04	5.62E-04	6.89E-04	1.11E-04
1,2,3,7,8-PeCDF	0.00147 - 0.00226	3	33.3	4.27E-04	4.27E-04	7.64E-04	3.52E-04
2,3,4,6,7,8-HxCDF	0.00147 - 0.00226	3	66.7	3.39E-04	7.81E-04	6.30E-04	2.52E-04
2,3,4,7,8-PeCDF	0.00147 - 0.00226	3	66.7	7.70E-04	0.00143	9.78E-04	3.92E-04
2,3,7,8-TCDD	5.87E-04 - 9.04E-04	3	33.3	5.33E-04	5.33E-04	4.26E-04	1.22E-04
2,3,7,8-TCDF[b]	5.87E-04 - 9.04E-04	3	33.3	0.00209	0.00209	9.45E-04	9.95E-04
Acenaphthene	21 - 330	11	9.09	360	360	366	208
Acetone	10 - 140	22	18.2	5	30	13.5	15.6
Anthracene	21 - 330	11	9.09	410	410	371	208
Aroclor-1254	8.2 - 160	9	11.1	120	120	238	155
Benzo(a)anthracene	25 - 330	11	18.2	59	83	328	237
Benzo(a)pyrene	25 - 330	11	9.09	79	79	359	221
Benzoic Acid	350 - 1,600	12	41.7	190	490	1,268	1,007
bis(2-ethylhexyl)phthalate	39 - 330	11	9.09	130	130	390	238
Chrysene	34 - 330	11	18.2	60	81	328	238
Di-n-butylphthalate	36 - 330	11	18.2	55	110	370	250
Fluoranthene	45 - 330	11	18.2	120	130	338	226
Heptachlorodibenzo-p-dioxin	0.00147 - 0.00226	3	66.7	0.00256	0.00285	0.00206	0.00113
Indeno(1,2,3-cd)pyrene	27 - 330	10	10	400	400	383	211
Methylene Chloride	1.5 - 7	23	26.1	2.80	23	4.77	4.68
Naphthalene	0.66 - 330	13	7.69	2	2	337	270
OCDD	0.00293 - 0.00452	3	100	0.00200	0.0159	0.0104	0.00739
OCDF	0.00293 - 0.00452	3	66.7	0.00176	0.00394	0.00239	0.00135
Pentachlorodibenzo-p-dioxin	0.00147 - 0.00226	3	33.3	3.72E-04	3.72E-04	6.26E-04	2.20E-04

Table 1.4
Summary of Detected Analytes in Subsurface Soil/Subsurface Sediment

Analyte	Range of Reported Detection Limits	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration	Standard Deviation
Phenanthrene	21 - 330	11	18.2	84	350	354	220
Tetrachloroethene	0.44 - 7	23	8.70	1	2	3.08	1.48
Toluene	0.99 - 7	24	75	3	520	76.6	148
Xylene[c]	0.77 - 14	23	4.35	1.60	1.60	3.10	1.45
Radionuclides (pCi/g)[d]							
Americium-241	0 - 0.24	31	N/A	-0.0430	0.390	0.0670	0.101
Cesium-134	0.02 - 0.0561	5	N/A	-0.0707	0.0500	0.00109	0.0458
Cesium-137	0.02 - 0.0464	5	N/A	0.00410	0.0800	0.0465	0.0336
Gross Alpha	1.5 - 22.21	23	N/A	-6.23	59	23.1	15.1
Gross Beta	2.4 - 19.2	23	N/A	9.07	46	24.1	7.46
Plutonium-238	0.0036 - 0.0101	3	N/A	0	0.0110	0.00411	0.00598
Plutonium-239/240	0.003 - 0.115	30	N/A	-0.0302	1.64	0.346	0.445
Radium-226	0.25 - 0.695	5	N/A	0.433	2.08	1.17	0.737
Radium-228	0.087 - 0.191	5	N/A	1.07	1.57	1.27	0.198
Strontium-89/90	0.0913 - 0.8477	5	N/A	-0.344	0.0304	-0.0618	0.160
Uranium-233/234	0 - 0.6181	21	N/A	0.612	3.50	1.52	0.808
Uranium-235	0 - 0.5271	21	N/A	-0.0571	0.341	0.0813	0.0789
Uranium-238	0 - 0.4697	21	N/A	0.717	3.36	1.46	0.690

[a] For inorganics and organics, statistics are computed using one-half the reported value for nondetects.

[b] All detections are "J" qualified, signifying that the reported result is below the detection limit, but above the instrument detection limit.

[c] The value for total xylene is used.

[d] All radionuclide values are considered detects.

N/A = Not applicable.

Table 1.5
Summary of Detected Analytes in Surface Soil

Analyte	Range of Reported Detection Limits	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration[a]	Standard Deviation[a]
Inorganics (mg/kg)							
Aluminum	4.9 - 50	74	100	3,900	30,000	15,019	6,250
Ammonia[b]	0.3	1	100	2.05	2.05	2.05	N/A
Antimony	0.29 - 50	60	46.7	0.300	9.80	1.48	2.39
Arsenic	0.82 - 3	74	100	2	8.80	5.84	1.71
Barium	0.37 - 40	74	100	46.8	240	146	43.0
Beryllium	0.1 - 5	74	89.2	0.180	1.50	0.815	0.271
Boron	1 - 1.3	46	93.5	2.30	13	7.00	2.08
Cadmium	0.066 - 5	73	60.3	0.110	1.30	0.408	0.238
Calcium	7.1 - 1000	74	100	1,300	33,000	5,534	4,790
Cesium[b]	200 - 500	14	14.3	2.70	7	20.5	26.8
Chromium	0.15 - 10	74	100	4.80	28	16.7	6.02
Cobalt	0.19 - 10	74	100	3.60	20.2	7.94	2.17
Copper	0.046 - 10	74	100	7.60	170	19.0	18.5
Iron	1.4 - 20	74	100	5,700	38,000	17,718	5,375
Lead	0.27 - 2	74	100	6.40	210	48.6	43.3
Lithium	0.49 - 20	58	94.8	1.80	22	12.5	4.60
Magnesium	7.7 - 1000	74	100	770	5,300	2,977	977
Manganese	0.18 - 10	74	100	113	1,200	375	170
Mercury	0.0052 - 0.2	58	60.3	0.0130	0.660	0.0446	0.0837
Molybdenum	0.3 - 40	59	74.6	0.370	1.30	0.887	0.644
Nickel	0.2 - 20	74	97.3	7.60	45.2	15.8	5.86
Nitrate / Nitrite[b]	0.2	1	100	0.800	0.800	0.800	N/A
Potassium	36 - 1000	74	100	614	5,160	2,983	901
Selenium	0.81 - 2	74	27.0	0.260	2	0.444	0.274
Silica[b]	4.4 - 5.6	46	100	560	1,300	978	158
Silicon[b]	0 - 100	5	100	425	2,000	1,407	590
Silver	0.079 - 10	66	6.06	0.150	1.60	0.244	0.364
Sodium	130 - 1000	74	24.3	47.8	643	80.2	69.0
Strontium	0.059 - 40	60	100	11.5	80	40.5	13.3
Thallium	0.92 - 2	74	47.3	0.250	5.70	0.930	0.936
Tin	0.86 - 100	60	18.3	1.70	85.9	5.16	12.7
Titanium	0.089 - 0.11	46	100	67	360	198	67.7
Vanadium	0.47 - 10	74	100	16.5	71	39.4	12.1
Zinc	0.46 - 10	74	100	17.9	86.1	56.7	13.4
Organics (µg/kg)							
Benzoic Acid	1600	9	44.4	180	700	1,200	907
bis(2-ethylhexyl)phthalate	330	9	11.1	70	70	282	150
Chrysene	330	9	11.1	42	42	279	155
Fluoranthene	330	9	11.1	79	79	283	148
Phenanthrene	330	9	11.1	46	46	280	154
Pyrene	330	9	11.1	70	70	282	150
Radionuclides (pCi/g)[c]							
Americium-241	0 - 0.287	88	N/A	-0.0153	1.66	0.302	0.341
Cesium-134	0.067 - 0.078	4	N/A	0.00200	0.0740	0.0380	0.0410
Cesium-137	0.013 - 0.19	4	N/A	0.649	1.18	0.845	0.233
Gross Alpha	1.9 - 20	7	N/A	-0.760	20.8	14.3	7.56
Gross Beta	1 - 20	7	N/A	19	43	32.6	8.06
Plutonium-238	0.0123 - 0.0293	6	N/A	0.00998	0.0601	0.0343	0.0198
Plutonium-239/240	0 - 0.132	94	N/A	-0.00192	12.2	1.89	2.28
Radium-226	0.25 - 0.5	5	N/A	0.985	1.20	1.09	0.0970
Radium-228	0.5 - 0.61	3	N/A	2.16	2.80	2.49	0.322
Strontium-89/90	0.2 - 0.3599	4	N/A	0.110	0.770	0.410	0.274
Uranium-233/234	0 - 0.683	35	N/A	0.334	2	1.12	0.322
Uranium-235	0 - 0.602	35	N/A	-0.0562	0.380	0.0589	0.0724
Uranium-238	0 - 0.457	35	N/A	0.477	2.20	1.18	0.332

[a] For inorganics and organics, statistics are computed using one-half the reported value for nondetects.

[b] All detections are "J" qualified, signifying that the reported result is below the detection limit, but above the instrument detection limit.

[c] All radionuclide values are considered detects.

N/A = Not applicable.

Table 1.6
Summary of Detected Analytes in Surface Soil (PMJM Habitat)

Analyte	Range of Reported Detection Limits	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration[a]	Standard Deviation[a]
Inorganics (mg/kg)							
Aluminum	4.9 - 50	45	100	3,900	28,000	16,960	5,900
Antimony	0.29 - 50	43	55.8	0.300	0.900	0.770	1.52
Arsenic	0.82 - 3	45	100	3.20	8.80	6.53	1.38
Barium	0.37 - 40	45	100	84	240	155	40.5
Beryllium	0.1 - 5	45	93.3	0.180	1.40	0.864	0.251
Boron	1 - 1.3	40	95	2.30	9.90	6.84	1.85
Cadmium	0.066 - 5	45	73.3	0.150	0.800	0.391	0.207
Calcium	7.1 - 1,000	45	100	1,300	7,570	4,148	1,253
Cesium[b]	200 - 500	3	33.3	7	7	44	32.1
Chromium	0.15 - 10	45	100	7.20	28	18.8	5.41
Cobalt	0.19 - 10	45	100	4.60	20.2	8.22	2.32
Copper	0.046 - 10	45	100	7.60	170	20.9	23.3
Iron	1.4 - 20	45	100	5,700	38,000	18,920	5,033
Lead	0.27 - 2	45	100	12	210	60.8	51.0
Lithium	0.49 - 10	42	100	2.90	20	13.6	4.01
Magnesium	7.7 - 1,000	45	100	770	5,000	3,144	958
Manganese	0.18 - 10	45	100	270	1,200	418	191
Mercury	0.0052 - 0.2	42	76.2	0.0130	0.0590	0.0328	0.0144
Molybdenum	0.3 - 40	43	88.4	0.370	1.30	0.731	0.481
Nickel	0.2 - 20	45	100	8.10	45.2	17.3	5.65
Potassium	36 - 1,000	45	100	930	4,600	3,190	837
Selenium	0.81 - 2	45	13.3	0.280	2	0.495	0.283
Silica[b]	4.4 - 5.6	40	100	560	1,300	960	152
Silicon[b]	100 - 100	2	100	1,670	1,770	1,720	70.7
Silver	0.079 - 10	44	2.27	0.160	0.160	0.121	0.262
Sodium	130 - 1,000	45	4.44	78.3	85.1	74.3	13.0
Strontium	0.059 - 40	43	100	21	62	39.5	9.48
Thallium	0.92 - 2	45	64.4	1.10	5.70	1.31	0.971
Tin	0.86 - 100	43	20.9	1.70	32.7	2.88	6.10
Titanium	0.089 - 0.11	40	100	68	360	203	66.3
Vanadium	0.47 - 10	45	100	20	59	42.4	9.29
Zinc	0.46 - 10	45	100	19	86.1	58.4	12.8
Organics (µg/kg)							
Benzoic Acid	1,600	2	100	300	410	355	77.8
Radionuclides (pCi/g)[c]							
Americium-241	0 - 0.171	36	N/A	7.00E-04	5.06	0.557	1.13
Cesium-134	0.073 - 0.079	2	N/A	0.00200	0.0730	0.0375	0.0502
Cesium-137	0.113 - 0.19	2	N/A	0.694	0.810	0.752	0.0820
Gross Alpha	2.2 - 3.5	3	N/A	19	36	25.3	9.34
Gross Beta	1 - 3.2	3	N/A	37.6	43	40.6	2.76
Plutonium-239/240	0 - 0.16	39	N/A	3.00E-04	191	7.99	30.6
Radium-226	0.267 - 0.3	2	N/A	1	1.23	1.12	0.163
Radium-228	0.57 - 0.57	1	N/A	2.50	2.50	2.50	N/A
Strontium-89/90	0.2 - 0.3599	2	N/A	0.340	0.418	0.379	0.0552
Uranium-233/234	0 - 0.683	14	N/A	0.829	2.30	1.24	0.370
Uranium-235	0 - 0.602	14	N/A	0.0198	0.360	0.0745	0.0899
Uranium-238	0 - 0.457	14	N/A	0.834	1.70	1.19	0.210

[a] For inorganics and organics, statistics are computed using one-half the reported value for nondetects.

[b] All detections are "J" qualified, signifying that the reported result is below the detection limit, but above the instrument detection limit.

[c] All radionuclide values are considered detects.

N/A = Not applicable.

41

Table 1.7
Summary of Detected Analytes in Subsurface Soil

Analyte	Range of Reported Detection Limits	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration	Standard Deviation
Inorganics (mg/kg)							
Aluminum	4.2 - 40	55	100	3,130	37,000	18,484	9,711
Antimony	0.27 - 12	53	30.2	0.300	20.2	2.29	3.85
Arsenic	0.23 - 2	55	100	1.60	15	5.81	2.46
Barium	0.13 - 40	55	100	34.6	270	155	59.6
Beryllium	0.026 - 1	55	100	0.230	1.60	0.984	0.354
Boron	0.97 - 2.1	35	97.1	2.30	11	7.14	2.01
Cadmium	0.027 - 1	52	65.4	0.0790	1.80	0.424	0.304
Calcium	1.3 - 1,000	55	100	1,170	98,200	9,079	16,257
Cesium[b]	84.9 - 200	17	29.4	0.860	2.65	16.5	21.4
Chromium	0.06 - 2	55	100	5.40	73.9	23.4	12.6
Cobalt	0.11 - 10	55	100	2.20	17.1	8.21	2.93
Copper	0.044 - 5	55	100	6.40	30	18.3	5.48
Iron	0.54 - 20	55	100	5,120	35,800	19,433	6,606
Lead	0.26 - 1.2	55	100	3.20	1,400	51.8	189
Lithium	0.29 - 20	55	100	2.80	26	13.9	6.67
Magnesium	3.7 - 1,000	55	100	874	6,570	3,624	1,510
Manganese	0.084 - 3	55	100	41	793	292	131
Mercury	0.0049 - 0.12	55	47.3	0.0120	1.80	0.122	0.355
Molybdenum	0.2 - 40	54	46.3	0.330	6.50	0.949	1.12
Nickel	0.19 - 8	55	100	5.20	49.9	18.6	7.31
Nitrate/Nitrite	0.2 - 0.2	6	100	0.700	1.30	1	0.253
Potassium	35 - 1,000	55	100	574	5,400	2,673	1,424
Selenium	0.28 - 1.9	54	14.8	0.270	1.50	0.445	0.273
Silica[b]	1.5 - 9.5	35	100	610	1,500	1,002	207
Silicon[b]	0	5	100	23.7	383	203	152
Silver	0.073 - 2	53	3.77	0.0940	0.120	0.188	0.195
Sodium	2.3 - 1,000	55	30.9	23.3	444	103	93.5
Strontium	0.057 - 400	55	100	10.9	401	58.6	62.7
Thallium	0.31 - 2	54	46.3	0.210	3.10	0.844	0.745
Tin	0.57 - 40	54	38.9	1	22.3	4.94	8.70
Titanium	0.085 - 0.3	35	100	41	370	197	80.4
Uranium	1.1 - 16	35	5.71	1.50	1.80	1.43	1.61
Vanadium	0.35 - 10	55	100	14	110	42.9	18.6
Zinc	0.38 - 4	55	100	18	110	57.7	20.5
Organics (µg/kg)							
1,2,3,4,6,7,8-HpCDF	0.00147 - 0.00226	3	66.7	8.32E-04	0.00158	0.00106	4.51E-04
1,2,3,4,7,8-HxCDF	0.00147 - 0.00226	3	33.3	0.00127	0.00127	9.25E-04	2.99E-04
1,2,3,6,7,8-HxCDF	0.00147 - 0.00226	3	33.3	5.62E-04	5.62E-04	6.89E-04	1.11E-04
1,2,3,7,8-PeCDF	0.00147 - 0.00226	3	33.3	4.27E-04	4.27E-04	7.64E-04	3.52E-04
2,3,4,6,7,8-HxCDF	0.00147 - 0.00226	3	66.7	3.39E-04	7.81E-04	6.30E-04	2.52E-04
2,3,4,7,8-PeCDF	0.00147 - 0.00226	3	66.7	7.70E-04	0.00143	9.78E-04	3.92E-04
2,3,7,8-TCDD	5.87E-04 - 9.04E-04	3	33.3	5.33E-04	5.33E-04	4.26E-04	1.22E-04
2,3,7,8-TCDF[b]	5.87E-04 - 9.04E-04	3	33.3	0.00209	0.00209	9.45E-04	9.95E-04
Acenaphthene	21 - 330	11	9.09	360	360	366	208
Acetone	10 - 140	22	18.2	5	30	13.5	15.6
Anthracene	21 - 330	11	9.09	410	410	371	208
Aroclor-1254	8.2 - 160	9	11.1	120	120	238	155
Benzo(a)anthracene	25 - 330	11	18.2	59	83	328	237
Benzo(a)pyrene	25 - 330	11	9.09	79	79	359	221
Benzoic Acid	350 - 1,600	12	41.7	190	490	1,268	1,007
bis(2-ethylhexyl)phthalate	39 - 330	11	9.09	130	130	390	238
Chrysene	34 - 330	11	18.2	60	81	328	238
Di-n-butylphthalate	36 - 330	11	18.2	55	110	370	250
Fluoranthene	45 - 330	11	18.2	120	130	338	226
Heptachlorodibenzo-p-dioxin	0.00147 - 0.00226	3	66.7	0.00256	0.00285	0.00206	0.00113
Indeno(1,2,3-cd)pyrene	27 - 330	10	10	400	400	383	211
Methylene Chloride	1.5 - 7	23	26.1	2.80	23	4.77	4.68
Naphthalene	0.66 - 330	13	7.69	2	2	337	270
OCDD	0.00293 - 0.00452	3	100	0.00200	0.0159	0.0104	0.00739
OCDF	0.00293 - 0.00452	3	66.7	0.00176	0.00394	0.00239	0.00135
Pentachlorodibenzo-p-dioxin	0.00147 - 0.00226	3	33.3	3.72E-04	3.72E-04	6.26E-04	2.20E-04

Table 1.7
Summary of Detected Analytes in Subsurface Soil

Analyte	Range of Reported Detection Limits	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration[a]	Standard Deviation
Phenanthrene	21 - 330	11	18.2	84	350	354	220
Tetrachloroethene	0.44 - 7	23	8.70	1	2	3.08	1.48
Toluene	0.99 - 7	24	75	3	520	76.6	148
Xylene[c]	0.77 - 14	23	4.35	1.60	1.60	3.10	1.45
Radionuclides (pCi/g)[d]							
Americium-241	0 - 0.24	31	N/A	-0.0430	0.390	0.0670	0.101
Cesium-134	0.02 - 0.0561	5	N/A	-0.0707	0.0500	0.00109	0.0458
Cesium-137	0.02 - 0.0464	5	N/A	0.00410	0.0800	0.0465	0.0336
Gross Alpha	1.5 - 22.21	23	N/A	-6.23	59	23.1	15.1
Gross Beta	2.4 - 19.2	23	N/A	9.07	46	24.1	7.46
Plutonium-238	0.0036 - 0.0101	3	N/A	0	0.0110	0.00411	0.00598
Plutonium-239/240	0.003 - 0.115	30	N/A	-0.0302	1.64	0.346	0.445
Radium-226	0.25 - 0.695	5	N/A	0.433	2.08	1.17	0.737
Radium-228	0.087 - 0.191	5	N/A	1.07	1.57	1.27	0.198
Strontium-89/90	0.0913 - 0.8477	5	N/A	-0.344	0.0304	-0.0618	0.160
Uranium-233/234	0 - 0.6181	21	N/A	0.612	3.50	1.52	0.808
Uranium-235	0 - 0.5271	21	N/A	-0.0571	0.341	0.0813	0.0789
Uranium-238	0 - 0.4697	21	N/A	0.717	3.36	1.46	0.690

[a] For inorganics and organics, statistics are computed using one-half the reported value for nondetects.

[b] All detections are "J" qualified, signifying that the reported result is below the detection limit, but above the instrument detection limit.

[c] The value for total xylene is used.

[d] All radionuclide values are considered detects.

N/A = Not applicable.

Table 1.8
Toxicity Equivalence Calculations for Dioxins/Furans - Human Health Receptors

Sampling Location	Sample Number	Analyte	Result (mg/kg)	Detect?	Validation Qualifier	TEF	TEQ Concentration[b] (mg/kg)
Surface Soil/Surface Sediment							
CR31-004	05F0140-005	1,2,3,4,6,7,8-HpCDF	0.000807	Yes	V	0.01	8.07E-06
CR31-004	05F0140-005	1,2,3,4,7,8-HxCDD	0.00271	No	V	0.1	0
CR31-004	05F0140-005	1,2,3,4,7,8-HxCDF	0.00271	No	V	0.1	0
CR31-004	05F0140-005	1,2,3,4,7,8,9-HpCDF	0.00271	No	V	0.01	0
CR31-004	05F0140-005	1,2,3,6,7,8-HxCDD	0.00271	No	V	0.1	0
CR31-004	05F0140-005	1,2,3,6,7,8-HxCDF	0.00271	No	V	0.1	0
CR31-004	05F0140-005	1,2,3,7,8-PeCDF	0.00271	No	V	0.05	0
CR31-004	05F0140-005	1,2,3,7,8,9-HxCDD	0.00271	No	V	0.1	0
CR31-004	05F0140-005	1,2,3,7,8,9-HxCDF	0.00271	No	V	0.1	0
CR31-004	05F0140-005	2,3,4,6,7,8-HxCDF	0.00271	No	V	0.1	0
CR31-004	05F0140-005	2,3,4,7,8-PeCDF	0.00271	No	V	0.5	0
CR31-004	05F0140-005	2,3,7,8-TCDD	0.00108	No	V	1	0
CR31-004	05F0140-005	2,3,7,8-TCDF	0.00108	No	V	0.1	0
CR31-004	05F0140-005	Heptachlorodibenzo-p-dioxin	0.00509	Yes	V	0.01	5.09E-05
CR31-004	05F0140-005	OCDD	0.0306	Yes	V	0.0001	3.06E-06
CR31-004	05F0140-005	OCDF	0.00128	Yes	V	0.0001	1.28E-07
CR31-004	05F0140-005	Pentachlorodibenzo-p-dioxin	0.00271	No	V	1	0
Total 2,3,7,8-TCDD TEQ Concentration for Sample 05F0140-005:							**6.22E-05**
2,3,7,8-TCDD TEQ Concentration used in Surface Soil/Surface Sediment PRG Screen[c]:							**6.22E-05**
Subsurface Soil/Subsurface Sediment							
CR31-004	05F0140-006	1,2,3,4,6,7,8-HpCDF	0.00158	Yes	V	0.01	1.58E-05
CR31-004	05F0140-006	1,2,3,4,7,8-HxCDD	0.00226	No	V	0.1	0
CR31-004	05F0140-006	1,2,3,4,7,8-HxCDF	0.00127	Yes	V	0.1	1.27E-04
CR31-004	05F0140-006	1,2,3,4,7,8,9-HpCDF	0.00226	No	V	0.01	0
CR31-004	05F0140-006	1,2,3,6,7,8-HxCDD	0.00226	No	V	0.1	0
CR31-004	05F0140-006	1,2,3,6,7,8-HxCDF	0.000562	Yes	V	0.1	5.62E-05
CR31-004	05F0140-006	1,2,3,7,8-PeCDF	0.00226	No	V	0.05	0
CR31-004	05F0140-006	1,2,3,7,8,9-HxCDD	0.00226	No	V	0.1	0
CR31-004	05F0140-006	1,2,3,7,8,9-HxCDF	0.00226	No	V	0.1	0
CR31-004	05F0140-006	2,3,4,6,7,8-HxCDF	0.000781	Yes	V	0.1	7.81E-05
CR31-004	05F0140-006	2,3,4,7,8-PeCDF	0.00143	Yes	V	0.5	7.15E-04
CR31-004	05F0140-006	2,3,7,8-TCDD	0.000904	No	V	1	0
CR31-004	05F0140-006	2,3,7,8-TCDF	0.000904	No	V	0.1	0
CR31-004	05F0140-006	Heptachlorodibenzo-p-dioxin	0.00285	Yes	V	0.01	2.85E-05
CR31-004	05F0140-006	OCDD	0.0133	Yes	V	0.0001	1.33E-06
CR31-004	05F0140-006	OCDF	0.00176	Yes	V	0.0001	1.76E-07
CR31-004	05F0140-006	Pentachlorodibenzo-p-dioxin	0.000372	Yes	V	1	3.72E-04
Total 2,3,7,8-TCDD TEQ Concentration for Sample 05F0140-006:							**0.00139**
CR31-004	05F0140-007	1,2,3,4,6,7,8-HpCDF	0.00154	No	V	0.01	0
CR31-004	05F0140-007	1,2,3,4,7,8-HxCDD	0.00154	No	V	0.1	0
CR31-004	05F0140-007	1,2,3,4,7,8-HxCDF	0.00154	No	V	0.1	0
CR31-004	05F0140-007	1,2,3,4,7,8,9-HpCDF	0.00154	No	V	0.01	0
CR31-004	05F0140-007	1,2,3,6,7,8-HxCDD	0.00154	No	V	0.1	0
CR31-004	05F0140-007	1,2,3,6,7,8-HxCDF	0.00154	No	V	0.1	0
CR31-004	05F0140-007	1,2,3,7,8-PeCDF	0.000427	Yes	V	0.05	2.14E-05
CR31-004	05F0140-007	1,2,3,7,8,9-HxCDD	0.00154	No	V	0.1	0
CR31-004	05F0140-007	1,2,3,7,8,9-HxCDF	0.00154	No	V	0.1	0
CR31-004	05F0140-007	2,3,4,6,7,8-HxCDF	0.00154	No	V	0.1	0
CR31-004	05F0140-007	2,3,4,7,8-PeCDF	0.00077	Yes	V	0.5	3.85E-04
CR31-004	05F0140-007	2,3,7,8-TCDD	0.000533	Yes	V	1	5.33E-04
CR31-004	05F0140-007	2,3,7,8-TCDF	0.00209	Yes	J	0.1	2.09E-04
CR31-004	05F0140-007	Heptachlorodibenzo-p-dioxin	0.00256	Yes	V	0.01	2.56E-05
CR31-004	05F0140-007	OCDD	0.0159	Yes	V	0.0001	1.59E-06
CR31-004	05F0140-007	OCDF	0.00394	Yes	V	0.0001	3.94E-07
CR31-004	05F0140-007	Pentachlorodibenzo-p-dioxin	0.00154	No	V	1	0
Total 2,3,7,8-TCDD TEQ Concentration for Sample 05F0140-007:							**0.00118**
CR31-004	05F0140-008	1,2,3,4,6,7,8-HpCDF	0.000832	Yes	V	0.01	8.32E-06
CR31-004	05F0140-008	1,2,3,4,7,8-HxCDD	0.00147	No	V	0.1	0
CR31-004	05F0140-008	1,2,3,4,7,8-HxCDF	0.00147	No	V	0.1	0
CR31-004	05F0140-008	1,2,3,4,7,8,9-HpCDF	0.00147	No	V	0.01	0
CR31-004	05F0140-008	1,2,3,6,7,8-HxCDD	0.00147	No	V	0.1	0
CR31-004	05F0140-008	1,2,3,6,7,8-HxCDF	0.00147	No	V	0.1	0

44

Table 1.8
Toxicity Equivalence Calculations for Dioxins/Furans - Human Health Receptors

Sampling Location	Sample Number	Analyte	Result (mg/kg)	Detect?	Validation Qualifier	TEF[a]	TEQ Concentration[b] (mg/kg)
CR31-004	05F0140-008	1,2,3,7,8-PeCDF	0.00147	No	V	0.05	0
CR31-004	05F0140-008	1,2,3,7,8,9-HxCDD	0.00147	No	V	0.1	0
CR31-004	05F0140-008	1,2,3,7,8,9-HxCDF	0.00147	No	V	0.1	0
CR31-004	05F0140-008	2,3,4,6,7,8-HxCDF	0.000339	Yes	V	0.1	3.39E-05
CR31-004	05F0140-008	2,3,4,7,8-PeCDF	0.00147	No	V	0.5	0
CR31-004	05F0140-008	2,3,7,8-TCDD	0.000587	No	V	1	0
CR31-004	05F0140-008	2,3,7,8-TCDF	0.000587	No	V	0.1	0
CR31-004	05F0140-008	Heptachlorodibenzo-p-dioxin	0.00153	No	V	0.01	0
CR31-004	05F0140-008	OCDD	0.002	Yes	V	0.0001	2.00E-07
CR31-004	05F0140-008	OCDF	0.00293	No	V	0.0001	0
CR31-004	05F0140-008	Pentachlorodibenzo-p-dioxin	0.00147	No	V	1	0
Total 2,3,7,8-TCDD TEQ Concentration for Sample 05F0140-008:							**4.24E-05**
2,3,7,8-TCDD TEQ Concentration used in Subsurface Soil/Subsurface Sediment PRG Screen[c]:							**0.00139**

[a]Toxicity equivalency factor (WHO, 1997).

[b]TEQ (toxicity equivalence) concentration = soil concentration x TEF. For nondetects, the TEQ concentration equals zero.

[c]The 2,3,7,8-TCDD TEQ concentration used in the PRG screen is the maximum of all sampling locations for the medium.

45

Table 1.9
Toxicity Equivalence Calculations for Dioxins/Furans - Ecological Receptors

Sampling Location	Sample Number	Congener	Result (mg/kg)	Detect?	Validation Qualifier	Mammals TEF[a]	Mammals TEQ Concentration[b] (mg/kg)
Subsurface Soil							
CR31-004	05F0140-007	1,2,3,4,6,7,8-HpCDF	0.00154	No	V	0.01	0
CR31-004	05F0140-007	1,2,3,4,7,8-HxCDD	0.00154	No	V	0.1	0
CR31-004	05F0140-007	1,2,3,4,7,8-HxCDF	0.00154	No	V	0.1	0
CR31-004	05F0140-007	1,2,3,4,7,8,9-HpCDF	0.00154	No	V	0.01	0
CR31-004	05F0140-007	1,2,3,6,7,8-HxCDD	0.00154	No	V	0.1	0
CR31-004	05F0140-007	1,2,3,6,7,8-HxCDF	0.00154	No	V	0.1	0
CR31-004	05F0140-007	1,2,3,7,8-PeCDF	0.000427	Yes	V	0.05	2.14E-05
CR31-004	05F0140-007	1,2,3,7,8,9-HxCDD	0.00154	No	V	0.1	0
CR31-004	05F0140-007	1,2,3,7,8,9-HxCDF	0.00154	No	V	0.1	0
CR31-004	05F0140-007	2,3,4,6,7,8-HxCDF	0.00154	No	V	0.1	0
CR31-004	05F0140-007	2,3,4,7,8-PeCDF	0.00077	Yes	V	0.5	3.85E-04
CR31-004	05F0140-007	2,3,7,8-TCDD	0.000533	Yes	V	1	5.33E-04
CR31-004	05F0140-007	2,3,7,8-TCDF	0.00209	Yes	J	0.1	2.09E-04
CR31-004	05F0140-007	Heptachlorodibenzo-p-dioxin	0.00256	Yes	V	0.01	2.56E-05
CR31-004	05F0140-007	OCDD	0.0159	Yes	V	0.0001	1.59E-06
CR31-004	05F0140-007	OCDF	0.00394	Yes	V	0.0001	3.94E-07
CR31-004	05F0140-007	Pentachlorodibenzo-p-dioxin	0.00154	No	V	1	0
Total 2,3,7,8-TCDD TEQ Concentration for Sample 050140-007:[c]							**0.00118**
CR31-004	05F0140-008	1,2,3,4,6,7,8-HpCDF	0.000832	Yes	V	0.01	8.32E-06
CR31-004	05F0140-008	1,2,3,4,7,8-HxCDD	0.00147	No	V	0.1	0
CR31-004	05F0140-008	1,2,3,4,7,8-HxCDF	0.00147	No	V	0.1	0
CR31-004	05F0140-008	1,2,3,4,7,8,9-HpCDF	0.00147	No	V	0.01	0
CR31-004	05F0140-008	1,2,3,6,7,8-HxCDD	0.00147	No	V	0.1	0
CR31-004	05F0140-008	1,2,3,6,7,8-HxCDF	0.00147	No	V	0.1	0
CR31-004	05F0140-008	1,2,3,7,8-PeCDF	0.00147	No	V	0.05	0
CR31-004	05F0140-008	1,2,3,7,8,9-HxCDD	0.00147	No	V	0.1	0
CR31-004	05F0140-008	1,2,3,7,8,9-HxCDF	0.00147	No	V	0.1	0
CR31-004	05F0140-008	2,3,4,6,7,8-HxCDF	0.000339	Yes	V	0.1	3.39E-05
CR31-004	05F0140-008	2,3,4,7,8-PeCDF	0.00147	No	V	0.5	0
CR31-004	05F0140-008	2,3,7,8-TCDD	0.000587	No	V	1	0
CR31-004	05F0140-008	2,3,7,8-TCDF	0.000587	No	V	0.1	0
CR31-004	05F0140-008	Heptachlorodibenzo-p-dioxin	0.00153	No	V	0.01	0
CR31-004	05F0140-008	OCDD	0.002	Yes	V	0.0001	2.00E-07
CR31-004	05F0140-008	OCDF	0.00293	No	V	0.0001	0
CR31-004	05F0140-008	Pentachlorodibenzo-p-dioxin	0.00147	No	V	1	0
Total 2,3,7,8-TCDD TEQ Concentration for Sample 05F0140-008:							**0.0000424**
2,3,7,8-TCDD TEQ Concentration used in Subsurface Soil ESL Screen[c]:							**0.00118**

[a]Toxicity equivalency factor (WHO, 1997).

[b]TEQ (toxicity equivalence) concentration = soil concentration x TEF. For nondetects, the TEQ concentration equals zero.

[c]The 2,3,7,8-TCDD TEQ concentration used in the ESL screen is the maximum of all sampling locations for the medium.

46

Table 2.1
Essential Nutrient Screen for Surface Soil/Surface Sediment

Analyte	MDC (mg/kg)	Estimated Maximum Daily Intake[a] (mg/day)	RDA/RDI/AI[b] (mg/day)	UL[b] (mg/day)	Retain for PRG Screen?
Calcium	47,700	4.77	500-1,200	2,500	No
Magnesium	5,800	0.580	80.0-420	65.0-110	No
Potassium	5,160	0.516	2,000-3,500	N/A	No
Sodium	643	0.064	500-2,400	N/A	No

[a] Based on the MDC and a 100-mg/day soil ingestion rate for a WRW.

[b] RDA/RDI/AI/UL taken from NAS 2000 and 2002.

N/A = Not available.

Table 2.2
PRG Screen for Surface Soil/Surface Sediment

Analyte	PRG[a]	MDC	MDC Exceeds PRG?	UCL[b]	UCL Exceeds PRG?	Retain for Detection Frequency Screen?
Inorganics (mg/kg)						
Aluminum	24,774	31,000	Yes	15,602	No	No
Ammonia	910,997	2.05	No	--	--	No
Antimony	44.4	9.80	No	--	--	No
Arsenic	**2.41**	**9.80**	**Yes**	**5.88**	**Yes**	**Yes**
Barium	2,872	330	No	--	--	No
Beryllium	100	6.70	No	--	--	No
Boron	9,477	14	No	--	--	No
Cadmium	91.4	1.80	No	--	--	No
Cesium	N/A	7	UT	--	--	UT
Chromium[c]	28.4	30	Yes	16.8	No	No
Cobalt	122	20.2	No	--	--	No
Copper	4,443	170	No	--	--	No
Iron	33,326	38,000	Yes	18,619	No	No
Lead	1,000	210	No	--	--	No
Lithium	2,222	28	No	--	--	No
Manganese	**419**	**1,580**	**Yes**	**422**	**Yes**	**Yes**
Mercury	32.9	0.680	No	--	--	No
Molybdenum	555	5.40	No	--	--	No
Nickel	2,222	45.2	No	--	--	No
Nitrate / Nitrite[d]	177,739	26.6	No	--	--	No
Selenium	555	2.80	No	--	--	No
Silica	N/A	1,600	UT	--	--	UT
Silicon	N/A	2,000	UT	--	--	UT
Silver	555	1.70	No	--	--	No
Strontium	66,652	167	No	--	--	No
Thallium	7.78	10	Yes	1.80	No	No
Tin	66,652	85.9	No	--	--	No
Titanium	169,568	360	No	--	--	No
Vanadium	111	71	No	--	--	No
Zinc	33,326	201	No	--	--	No
Organics (mg/kg)						
2,3,7,8-TCDD TEQ[e]	0.0250	6.22E-05	No	--	--	No
2,4-Dinitrophenol	160,287	890	No	--	--	No
2-Butanone	4.64E+07	63	No	--	--	No
4,6-Dinitro-2-methylphenol	8,014	750	No	--	--	No
4-Methyl-2-pentanone	8.32E+07	3	No	--	--	No
4-Methylphenol	400,718	200	No	--	--	No
Acenaphthene	4.44E+06	320	No	--	--	No
Acetone	1.00E+08	66	No	--	--	No
Aldrin	176	0	No	--	--	No
alpha-Chlordane	10,261	0	No	--	--	No
Anthracene	2.22E+07	450	No	--	--	No
Aroclor-1254	1,349	220	No	--	--	No
Benzo(a)anthracene	3,793	190	No	--	--	No
Benzo(a)pyrene	379	170	No	--	--	No
Benzo(b)fluoranthene	3,793	180	No	--	--	No
Benzo(g,h,i)perylene	N/A	150	UT	--	--	UT
Benzo(k)fluoranthene	37,927	150	No	--	--	No
Benzoic Acid	3.21E+08	700	No	--	--	No
beta-BHC	1,995	0	No	--	--	No
bis(2-ethylhexyl)phthalate	213,750	2,200	No	--	--	No
Butylbenzylphthalate	1.60E+07	57	No	--	--	No
Chrysene	379,269	190	No	--	--	No
delta-BHC	570	0	No	--	--	No
Dibenz(a,h)anthracene	379	530	No	--	--	No
Di-n-butylphthalate	8.01E+06	70	No	--	--	No
Endosulfan I	480,861	0	No	--	--	No
Fluoranthene	2.96E+06	330	No	--	--	No
gamma-BHC (Lindane)	2,771	4.40	No	--	--	No
gamma-Chlordane	10,261	0	No	--	--	No
Heptachlor	665	0	No	--	--	No
Heptachlor epoxide	329	0	No	--	--	No

48

Table 2.2
PRG Screen for Surface Soil/Surface Sediment

Analyte	PRG[a]	MDC	MDC Exceeds PRG?	UCL[b]	UCL Exceeds PRG?	Retain for Detection Frequency Screen?
Indeno(1,2,3-cd)pyrene	3,793	500	No	--	--	No
Methylene Chloride	271,792	16	No	--	--	No
Pentachlorophenol	17,633	950	No	--	--	No
Phenanthrene	N/A	360	UT	--	--	UT
Phenol	2.40E+07	150	No	--	--	No
Pyrene	2.22E+06	310	No	--	--	No
Toluene	3.09E+06	410	No	--	--	No
Radionuclides (pCi/g)						
Americium-241	7.69	1.66	No	--	--	No
Cesium-134	**0.0800**	**0.200**	**Yes**	**0.111**	**Yes**	**Yes**
Cesium-137	**0.221**	**1.18**	**Yes**	**0.508**	**Yes**	**Yes**
Gross Alpha	N/A	152	UT	--	--	UT
Gross Beta	N/A	45	UT	--	--	UT
Plutonium-238	5.97	0.0601	No	--	--	No
Plutonium-239/240	9.80	12.2	Yes	2.31	No	No
Radium-226	2.69	2	No	--	--	No
Radium-228	**0.111**	**2.80**	**Yes**	**2.26**	**Yes**	**Yes**
Strontium-89/90	13.2	3.24	No	--	--	No
Uranium-233/234	25.3	3.19	No	--	--	No
Uranium-235	1.05	0.405	No	--	--	No
Uranium-238	29.3	3.39	No	--	--	No

[a] The value shown is equal to the most stringent of the PRGs based on a risk of 1E-06 or an HQ of 0.1.

[b] UCL = 95% upper confidence limit on the mean, unless the MDC < UCL, then the MDC is used as the UCL.

[c] The PRG for chromium (VI) is used.

[d] The PRG for nitrate is used.

[e] The TEQ for 2,3,7,8-TCDD is calculated in Table 1.8 and the PRG for 2,3,7,8-TCDD is used in the PRG screen.

N/A = Not available.

UT = Uncertain toxicity; no PRG available (assessed in Section 6.0).

-- = Screen not performed because analyte was eliminated from further consideration in a previous COC selection step.

Bold = Analyte retained for further consideration in the next COC selection step.

49

Table 2.3

Statistical Distributions and Comparison to Background for LWOEU[a]

Analyte	Statistical Distribution Testing Results						Background Comparison		
	Background			LWOEU					
	Total Samples	Distribution Recommended	Detects (%)	Total Samples	Distribution Recommended	Detects (%)	Test	1-p	Retain as PCOC?
Surface Soil/Surface Sediment									
Arsenic	**73**	**GAMMA**	**92**	**106**	**NON-PARAMETRIC**	**100**	**WRS**	**1.14E-09**	**Yes**
Manganese	**73**	**GAMMA**	**100**	**106**	**NON-PARAMETRIC**	**100**	**WRS**	**5.44E-12**	**Yes**
Cesium-134	77	NON-PARAMETRIC	N/A	13	NORMAL	N/A	WRS	0.994	No
Cesium-137	105	NON-PARAMETRIC	N/A	19	GAMMA	N/A	WRS	0.995	No
Radium-228	**40**	**GAMMA**	**N/A**	**9**	**NORMAL**	**N/A**	**WRS**	**0.0478**	**Yes**
Subsurface Soil/Subsurface Sediment									
Radium-228	31	GAMMA	N/A	5	NORMAL	N/A	WRS	0.912	No

[a] EU data for background comparison do not include data from background locations.

WRS = Wilcoxon Rank Sum

N/A = Not applicable; all radionuclide values are considered detect.

Bold = Analyte retained for further consideration in the next COC selection step.

Table 2.4
Essential Nutrient Screen for Subsurface Soil/Subsurface Sediment

Analyte	MDC (mg/kg)	Estimated Maximum Daily Intake[a] (mg/day)	RDA/RDI/AI[b] (mg/day)	UL[b] (mg/day)	Retain for PRG Screen?
Calcium	98,200	9.82	500-1,200	2,500	No
Magnesium	6,570	0.657	80.0-420	65.0-110	No
Potassium	5,400	0.540	2,000-3,500	N/A	No
Sodium	444	0.044	500-2,400	N/A	No

[a] Based on the MDC and a 100-mg/day soil ingestion rate for a WRW.

[b] RDA/RDI/AI/UL taken from NAS 2000 and 2002.

N/A = Not available.

51

Table 2.5
PRG Screen for Subsurface Soil/Subsurface Sediment

Analyte	PRG[a]	MDC	MDC Exceeds PRG?	UCL[b]	UCL Exceeds PRG?	Retain for Detection Frequency Screen?
Inorganics (mg/kg)						
Aluminum	284,902	37,000	No	--	--	No
Antimony	511	20.2	No	--	--	No
Arsenic	27.7	15	No	--	--	No
Barium	33,033	270	No	--	--	No
Beryllium	1,151	1.60	No	--	--	No
Boron	108,980	11	No	--	--	No
Cadmium	1,051	1.80	No	--	--	No
Cesium	N/A	2.65	UT	--	--	UT
Chromium[c]	327	73.9	No	--	--	No
Cobalt	1,401	17.1	No	--	--	No
Copper	51,100	30	No	--	--	No
Iron	383,250	35,800	No	--	--	No
Lead	1,000	1,400	Yes	230	No	No
Lithium	25,550	26	No	--	--	No
Manganese	4,815	793	No	--	--	No
Mercury	379	1.80	No	--	--	No
Molybdenum	6,388	6.50	No	--	--	No
Nickel	25,550	49.9	No	--	--	No
Nitrate / Nitrite[d]	2.04E+06	1.30	No	--	--	No
Selenium	6,388	1.50	No	--	--	No
Silica	N/A	1,500	UT	--	--	UT
Silicon	N/A	383	UT	--	--	UT
Silver	6,388	0.120	No	--	--	No
Strontium	766,500	401	No	--	--	No
Thallium	89.4	3.10	No	--	--	No
Tin	766,500	22.3	No	--	--	No
Titanium	1.95E+06	370	No	--	--	No
Uranium	3,833	1.80	No	--	--	No
Vanadium	1,278	110	No	--	--	No
Zinc	383,250	110	No	--	--	No
Organics (µg/kg)						
2,3,7,8-TCDD TEQ[e]	0.285	0.00139	No	--	--	No
Acenaphthene	5.10E+07	360	No	--	--	No
Acetone	1.15E+09	30	No	--	--	No
Anthracene	2.55E+08	410	No	--	--	No
Aroclor-1254	15,514	120	No	--	--	No
Benzo(a)anthracene	43,616	83	No	--	--	No
Benzo(a)pyrene	4,357	79	No	--	--	No
Benzoic Acid	3.69E+09	490	No	--	--	No
bis(2-ethylhexyl)phthalate	2.46E+06	130	No	--	--	No
Chrysene	4.36E+06	81	No	--	--	No
Di-n-butylphthalate	9.22E+07	110	No	--	--	No
Fluoranthene	3.40E+07	130	No	--	--	No
Indeno(1,2,3-cd)pyrene	43,616	400	No	--	--	No
Methylene Chloride	3.13E+06	23	No	--	--	No
Naphthalene	1.61E+07	2	No	--	--	No
Phenanthrene	N/A	350	UT	--	--	UT
Tetrachloroethene	77,111	2	No	--	--	No
Toluene	3.56E+07	520	No	--	--	No
Xylene	1.22E+07	1.60	No	--	--	No
Radionuclides (pCi/g)						
Americium-241	88.4	0.390	No	--	--	No
Cesium-134	0.910	0.050	No	--	--	No
Cesium-137	2.54	0.080	No	--	--	No
Gross Alpha	N/A	59.0	UT	--	--	UT
Gross Beta	N/A	46.0	UT	--	--	UT
Plutonium-238	68.7	0.011	No	--	--	No
Plutonium-239/240	112	1.64	No	--	--	No
Radium-226	31.0	2.08	No	--	--	No
Radium-228	**1.28**	**1.57**	**Yes**	**1.46**	**Yes**	**Yes**
Strontium-89/90	152	0.030	No	--	--	No
Uranium-233/234	291	3.50	No	--	--	No
Uranium-235	12.1	0.341	No	--	--	No
Uranium-238	337	3.36	No	--	--	No

[a] The value shown is equal to the most stringent of the PRGs based on a risk of 1E-06 or an HQ of 0.1.

[b] UCL = 95% upper confidence limit on the mean, unless the MDC < UCL, then the MDC is used as the UCL.

[c] The PRG for chromium (VI) is used.

[d] The PRG for nitrate is used.

[e] The TEQ for 2,3,7,8-TCDD is calculated in Table 1.8 and the PRG for 2,3,7,8-TCDD is used in the PRG screen.

N/A = Not available.

UT = Uncertain toxicity; no PRG available (assessed in Section 6.0).

-- = Screen not performed because analyte was eliminated from further consideration in a previous COC selection step.

Bold = Analyte retained for further consideration in the next COC selection step.

52

Table 2.6
Summary of the COC Selection Process

Analyte	MDC Exceeds PRG?	UCL Exceeds PRG?	Detection Frequency > 5%[a]	Exceeds 30X the PRG?	Exceeds Background?	Professional Judgment Retain?	Retain as COC?
Surface Soil/Surface Sediment							
Aluminum	Yes	No	--	--	--	--	No
Arsenic	Yes	Yes	Yes	N/A	Yes	No	No
Chromium	Yes	No	--	--	--	--	No
Iron	Yes	No	--	--	--	--	No
Manganese	Yes	Yes	Yes	N/A	Yes	No	No
Thallium	Yes	No	--	--	--	--	No
Cesium-134	Yes	Yes	N/A	N/A	No	--	No
Cesium-137	Yes	Yes	N/A	N/A	No	--	No
Plutonium-239/240	Yes	No	--	--	--	--	No
Radium-228	Yes	Yes	N/A	N/A	Yes	No	No
Subsurface Soil/Subsurface Sediment							
Lead	Yes	No	--	--	--	--	No
Radium-228	Yes	Yes	N/A	N/A	No	--	No

[a] All radionuclide values are considered detects.
N/A = Not applicable.
-- = Screen not performed because analyte was eliminated from further consideration in a previous COC selection step.

63

Table 6.1
Summary of Detected PCOCs without PRGs in Each Medium by Analyte Suite[a]

PCOC	Surface Soil/Surface Sediment	Subsurface Soil/Subsurface Sediment
Inorganics		
Cesium	X[b]	X[b]
Silica	X[b]	X[b]
Silicon	X[b]	X[b]
Organics		
Benzo(g,h,i)perylene	X	N/A
Phenanthrene	X	X
Radionuclides		
Gross Alpha	X	X
Gross Beta	X	X

[a] Does not include essential nutrients or Dioxin/Furan congeners. Essential nutrients without PRGs were evaluated by comparing estimated intakes to recommended intakes. Dioxin and Furan congeners were evaluated by calculating the 2,3,7,8-TCDD Equivalents (TEQ), which are presented in Table 1.8.

[b] All detections are "J" qualified, signifying that the reported result is below the detection limit, but above the instrument detection limit.

X = PRG is unavailable.

N/A = Not applicable. Analyte not detected or not analyzed.

Table 7.1
Comparison of MDCs in Surface Soil to NOAEL ESLs for Terrestrial Plants, Invertebrates, and Vertebrates in the LWOEU

ECOI	MDC	Terrestrial Plants		Terrestrial Invertebrates		Mourning Dove Herbivore		Mourning Dove Insectivore		American Kestrel		Deer Mouse Herbivore		Deer Mouse Insectivore		Prairie Dog		Mule Deer		Coyote Carnivore		Coyote Generalist		Coyote Insectivore		Terrestrial Receptor[a]		Most Sensitive Receptor	Retain for Further Analysis?
		NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	Results	
Inorganics (mg/kg)																													
Aluminum	30,000	**50**	Yes	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Terrestrial Plants	Yes
Ammonia	2.05	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	7,316	No	586	No	26,723	No	37,008	No	2,247	No	2,311	No	2,539	No	N/A	N/A	Deer Mouse Insectivore	No
Antimony	9.80	**5**	Yes	78	No	N/A	N/A	N/A	N/A	N/A	N/A	9.89	No	0.905	Yes	18.7	No	57.6	No	138	No	13.2	No	**3.85**	Yes	N/A	N/A	Deer Mouse Insectivore	Yes
Arsenic	8.80	10	No	60	No	20	No	164	No	1,028	No	**2.57**	Yes	51.4	No	9.35	No	13.0	No	709	No	341	No	293	No	N/A	N/A	Deer Mouse Herbivore	Yes
Barium	240	500	No	330	No	**159**	Yes	357	No	1,317	No	930	No	4,427	No	3,224	No	4,766	No	24,896	No	19,838	No	18,369	No	N/A	N/A	Mourning Dove Herbivore	Yes
Beryllium	1.50	10	No	40	No	N/A	N/A	N/A	N/A	N/A	N/A	160	No	6.82	No	211	No	896	No	1,072	No	103	No	29.2	No	N/A	N/A	Deer Mouse Insectivore	No
Boron	13	**0.5**	Yes	N/A	N/A	30	No	115	No	167	No	62.1	No	422	No	237	No	314	No	929	No	6,070	No	1,816	No	N/A	N/A	Terrestrial Plants	Yes
Cadmium	1.30	32	No	140	No	28	No	**0.705**	Yes	15.0	No	59.9	No	1.56	No	198	No	723	No	1,360	No	51.2	No	9.75	No	N/A	N/A	Mourning Dove Insectivore	Yes
Calcium	33,000	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Cesium	7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Chromium[b]	28	**1**	Yes	**0.4**	Yes	**25**	Yes	**1.34**	Yes	**14.0**	Yes	281	No	**15.9**	Yes	703	No	1,461	No	4,173	No	250	No	68.5	No	N/A	N/A	Terrestrial Invertebrates	Yes
Cobalt	20.2	**13**	Yes	N/A	N/A	278	No	87.0	No	440	No	1,476	No	363	No	2,461	No	7,902	No	3,785	No	2,492	No	1,519	No	N/A	N/A	Terrestrial Plants	Yes
Copper	170	**100**	Yes	**50**	Yes	**29**	Yes	**8.25**	Yes	**164**	Yes	295	No	605	No	838	No	4,119	No	5,459	No	3,000	No	4,641	No	N/A	N/A	Mourning Dove Insectivore	Yes
Iron	38,000	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Lead	210	**110**	Yes	**1700**	Yes	**50**	Yes	**12.1**	Yes	**95.8**	Yes	1,344	No	242	No	1,850	No	9,798	No	8,927	No	3,066	No	1,393	No	N/A	N/A	Mourning Dove Insectivore	Yes
Lithium	22	**2**	Yes	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1,882	No	610	No	3,178	No	10,173	No	18,431	No	5,608	No	2,560	No	N/A	N/A	Terrestrial Plants	Yes
Magnesium	5,300	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Manganese	1,200	**500**	Yes	N/A	N/A	**1,032**	Yes	2,631	No	9,917	No	**486**	Yes	4,080	No	1,519	No	2,506	No	14,051	No	10,939	No	19,115	No	N/A	N/A	Deer Mouse Herbivore	Yes
Mercury	0.660	**0.3**	Yes	**0.1**	Yes	**0.197**	Yes	**0.0001**	Yes	1.57	No	**0.439**	Yes	**0.179**	Yes	3.15	No	7.56	No	8.18	No	8.49	No	37.3	No	N/A	N/A	Mourning Dove Insectivore	Yes
Molybdenum	1.30	2	No	N/A	N/A	44	No	6.97	No	76.7	No	8.68	No	1.90	No	27.1	No	44.3	No	275	No	28.9	No	8.18	No	N/A	N/A	Deer Mouse Insectivore	No
Nickel	45.2	**30**	Yes	200	No	**44**	Yes	**1.24**	Yes	**13.1**	Yes	**16.4**	Yes	**0.431**	Yes	38.3	Yes	124	No	90.9	No	**6.02**	Yes	**1.86**	Yes	N/A	N/A	Deer Mouse Insectivore	Yes
Nitrate / Nitrite[c]	0.800	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4,478	No	7,647	No	16,233	No	22,660	No	32,879	No	32,190	No	32,879	No	N/A	N/A	Deer Mouse Herbivore	No
Potassium	5,160	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Selenium	2	**1**	Yes	70	No	**1.61**	Yes	**1**	Yes	8.5	No	**0.872**	Yes	**0.754**	Yes	2.80	No	3.82	No	32.5	No	12.2	No	5.39	No	N/A	N/A	Deer Mouse Insectivore	Yes
Silica	1,300	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Silicon	2,000	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Silver	1.60	2	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Terrestrial Plants	No
Sodium	643	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Strontium	80	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	940	No	13,578	No	3,519	No	4,702	No	584,444	No	144,904	No	57,298	No	N/A	N/A	Deer Mouse Herbivore	No
Thallium	5.70	**1**	Yes	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	180	No	7.24	No	204	No	1,039	No	212	No	81.6	No	30.8	No	N/A	N/A	Terrestrial Plants	Yes
Tin	85.9	**50**	Yes	N/A	N/A	**26**	Yes	**2.90**	Yes	**19**	Yes	**45.0**	Yes	**3.77**	Yes	**80.6**	Yes	242	No	**70.0**	Yes	**36.1**	Yes	**16.2**	Yes	N/A	N/A	Mourning Dove Insectivore	Yes
Titanium	360	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Vanadium	71	**2**	Yes	N/A	N/A	503	No	274	No	1,514	No	**63.7**	Yes	**29.9**	Yes	83.5	No	358	No	341	No	164	No	121	No	N/A	N/A	Terrestrial Plants	Yes
Zinc	86.1	**50**	Yes	200	No	109	No	**0.646**	Yes	113	No	171	No	**5.29**	Yes	1,174	No	2,772	No	16,489	No	3,887	No	431	No	N/A	N/A	Mourning Dove Insectivore	Yes
Organics (µg/kg)																													
Benzoic Acid	700	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
bis(2-ethylhexyl)phthalate	70	N/A	N/A	N/A	N/A	19,547	No	137	No	398	No	960,345	No	8,071	No	2,759,555	No	4,931,556	No	42,305	No	40,167	No	34,967	No	N/A	N/A	Mourning Dove Insectivore	No
Chrysene	42	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Fluoranthene	79	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Phenanthrene	46	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Pyrene	70	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Radionuclides (pCi/g)																													
Americium-241	1.66	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3,890	N/A	N/A	No
Cesium-134	0.0740	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Cesium-137	1.18	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	20.8	No	N/A	No
Gross Alpha	20.8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Gross Beta	43	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Plutonium-238	0.0601	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Plutonium-239/240	12.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	6,110	No	N/A	No
Radium-226	1.20	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	50.6	No	N/A	No
Radium-228	2.80	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	43.9	No	N/A	No
Strontium-89/90	0.770	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	22.5	No	N/A	No
Uranium-233/234	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4,980	No	N/A	No
Uranium-235	0.380	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2,770	No	N/A	No
Uranium-238	2.20	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1,580	No	N/A	No

[a]Radionuclide ESLs are not receptor-specific. They are considered protective of all terrestrial ecological species.

[b]The ESLs for chromium were developed using available toxicity data based on chromium III (birds) and chromium VI (plants, invertebrates, and mammals).

[b]The ESLs for nitrate are used.

N/A = Indicates no ESL was available for that ECOI/receptor pair.

UT = Uncertain toxicity; no ESL available (assessed in Section 10.0).

Bold = Analyte retained for further consideration in the next ECOPC selection step.

Table 7.2
Summary of Non-PMJM NOAEL ESL Screening Results for Surface Soil in the LWOEU

Analyte	Terrestrial Plant Exceedance?	Terrestrial Invertebrate Exceedance?	Terrestrial Vertebrate Exceedance?
Inorganics			
Aluminum	**Yes**	UT	UT
Ammonia	UT	UT	No
Antimony	**Yes**	No	**Yes**
Arsenic	No	No	**Yes**
Barium	No	No	**Yes**
Beryllium	No	No	No
Boron	**Yes**	UT	No
Cadmium	No	No	**Yes**
Calcium	UT	UT	UT
Cesium	UT	UT	UT
Chromium	**Yes**	**Yes**	**Yes**
Cobalt	**Yes**	UT	No
Copper	**Yes**	**Yes**	**Yes**
Iron	UT	UT	UT
Lead	**Yes**	No	**Yes**
Lithium	**Yes**	UT	No
Magnesium	UT	UT	UT
Manganese	**Yes**	UT	**Yes**
Mercury	**Yes**	**Yes**	**Yes**
Molybdenum	No	UT	No
Nickel	**Yes**	No	**Yes**
Nitrate / Nitrite	UT	UT	No
Potassium	UT	UT	UT
Selenium	**Yes**	No	**Yes**
Silica	UT	UT	UT
Silicon	UT	UT	UT
Silver	No	UT	UT
Sodium	UT	UT	UT
Strontium	UT	UT	No
Thallium	**Yes**	UT	No
Tin	**Yes**	UT	**Yes**
Titanium	UT	UT	UT
Vanadium	**Yes**	UT	**Yes**
Zinc	**Yes**	No	**Yes**
Organics			
Benzoic Acid	UT	UT	UT
bis(2-ethylhexyl)phthalate	UT	UT	No
Chrysene	UT	UT	UT
Fluoranthene	UT	UT	UT
Phenanthrene	UT	UT	UT
Pyrene	UT	UT	UT
Radionuclides			
Americium-241	UT	UT	No
Cesium-134	UT	UT	UT
Cesium-137	UT	UT	No
Gross Alpha	UT	UT	UT

Table 7.2
Summary of Non-PMJM NOAEL ESL Screening Results for Surface Soil in the LWOEU

Analyte	Terrestrial Plant Exceedance?	Terrestrial Invertebrate Exceedance?	Terrestrial Vertebrate Exceedance?
Gross Beta	UT	UT	UT
Plutonium-238	UT	UT	UT
Plutonium-239/240	UT	UT	No
Radium-226	UT	UT	No
Radium-228	UT	UT	No
Strontium-89/90	UT	UT	No
Uranium-233/234	UT	UT	No
Uranium-235	UT	UT	No
Uranium-238	UT	UT	No

UT = Uncertain toxicity; no ESL available (assessed in Section 10.0).
Bold = Analyte retained for further consideration in the next ECOPC selection step.

Table 7.3

Comparison of MDCs in Surface Soil with NOAEL ESLs for the PMJM in the LWOEU

Analyte	MDC	PMJM NOAEL ESL	EPC> PMJM ESL?
Inorganics (mg/kg)			
Aluminum	28,000	N/A	UT
Antimony	0.900	1	No
Arsenic	**8.80**	**2.21**	**Yes**
Barium	240	743	No
Beryllium	1.40	8.16	No
Boron	9.90	52.7	No
Cadmium	0.800	1.75	No
Calcium	7,570	N/A	UT
Cesium	7	N/A	UT
Chromium[a]	**28**	**19.3**	**Yes**
Cobalt	20.2	340	No
Copper	170	95.0	**Yes**
Iron	38,000	N/A	UT
Lead	210	220	No
Lithium	20	519	No
Magnesium	5,000	N/A	UT
Manganese	**1,200**	**388**	**Yes**
Mercury	**0.0590**	**0.0521**	**Yes**
Molybdenum	1.30	1.84	No
Nickel	**45.2**	**0.510**	**Yes**
Potassium	4,600	N/A	UT
Selenium	**2**	**0.421**	**Yes**
Silica	1,300	N/A	UT
Silicon	1,770	N/A	UT
Silver	0.160	N/A	UT
Sodium	85.1	N/A	UT
Strontium	62	833	No
Thallium	5.70	8.64	No
Tin	**32.7**	**4.22**	**Yes**
Titanium	360	N/A	UT
Vanadium	**59**	**21.6**	**Yes**
Zinc	**86.1**	**6.41**	**Yes**
Organics (µg/kg)			
Benzoic Acid	410	N/A	UT
Radionuclides (pCi/g)			
Americium-241	5.06	3,890	No
Cesium-134	0.0730	N/A	UT
Cesium-137	0.810	20.8	No
Gross Alpha	36	N/A	UT
Gross Beta	43	N/A	UT
Plutonium-239/240	191	6,110	No
Radium-226	1.23	50.6	No
Radium-228	2.50	43.9	No
Strontium-89/90	0.418	22.5	No
Uranium-233/234	2.30	4,980	No
Uranium-235	0.360	2,770	No
Uranium-238	1.70	1,580	No

[a] The ESL for chromium VI is used.

N/A = No ESL available.

UT = Uncertain toxicity; no ESL available (assessed in Section 10.0).

Bold = Analyte retained for further consideration in the next ECOPC selection step.

Table 7.4
Statistical Distribution and Comparison to Background for Surface Soil (Non-PMJM) in the LWOEU

Analyte	Statistical Distribution Testing Results						Background Comparison		
	Background			LWOEU					
	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Test	1 - p	Retain as ECOI?
Inorganics (mg/kg)									
Aluminum	**20**	**NORMAL**	**100**	**74**	**NORMAL**	**100**	**WRS**	**6.51E-04**	**Yes**
Antimony	**20**	**NONPARAMETRIC**	**0**	**60**	**NONPARAMETRIC**	**47**	**N/A**	**N/A**	**Yes**[a]
Arsenic	20	NORMAL	100	74	NONPARAMETRIC	100	WRS	0.611	No
Barium	**20**	**NORMAL**	**100**	**74**	**NORMAL**	**100**	**WRS**	**1.24E-05**	**Yes**
Boron	**N/A**	**N/A**	**N/A**	**46**	**NORMAL**	**93**	**N/A**	**N/A**	**Yes**[a]
Cadmium	20	NONPARAMETRIC	65	73	GAMMA	60	WRS	1.000	No
Chromium	**20**	**NORMAL**	**100**	**74**	**NORMAL**	**100**	**WRS**	**8.71E-05**	**Yes**
Cobalt	20	NORMAL	100	74	NONPARAMETRIC	100	WRS	0.120	No
Copper	**20**	**NONPARAMETRIC**	**100**	**74**	**NONPARAMETRIC**	**100**	**WRS**	**4.42E-05**	**Yes**
Lead	20	NORMAL	100	74	NONPARAMETRIC	100	WRS	0.389	No
Lithium	**20**	**NORMAL**	**100**	**58**	**NORMAL**	**95**	**WRS**	**1.13E-05**	**Yes**
Manganese	**20**	**NORMAL**	**100**	**74**	**NONPARAMETRIC**	**100**	**WRS**	**4.69E-07**	**Yes**
Mercury	20	NONPARAMETRIC	40	58	NONPARAMETRIC	60	WRS	1.000	No
Nickel	**20**	**NORMAL**	**100**	**74**	**GAMMA**	**97**	**WRS**	**6.22E-07**	**Yes**
Selenium	20	NONPARAMETRIC	60	74	NONPARAMETRIC	27	WRS	0.982	No
Thallium	**14**	**NORMAL**	**0**	**74**	**NONPARAMETRIC**	**47**	**N/A**	**N/A**	**Yes**[a]
Tin	**20**	**NORMAL**	**0**	**60**	**NONPARAMETRIC**	**18**	**N/A**	**N/A**	**Yes**[a]
Vanadium	**20**	**NORMAL**	**100**	**74**	**NORMAL**	**100**	**WRS**	**4.27E-05**	**Yes**
Zinc	**20**	**NORMAL**	**100**	**74**	**NORMAL**	**100**	**WRS**	**0.020**	**Yes**

[a] Statistical comparisons to background cannot be performed. The analyte is retained as an ECOI for further evaluation.
WRS = Wilcoxon Rank Sum
N/A = Not applicable; site and/or background detection frequency less than 20%.
Bold = Analyte retained for further consideration in the next ECOPC selection step.

60

Table 7.5
Statistical Distribution and Comparison to Background for Surface Soil in PMJM Habitat in the LWOEU

Analyte	Statistical Distribution Testing Results						Background Comparison		
	Background			LWOEU			Test	1 - p	Retain as ECOI?
	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)			
Inorganics									
Arsenic	20	NORMAL	100	45	NON-PARAMETRIC	100	WRS	0.120	No
Chromium	**20**	**NORMAL**	**100**	**45**	**NORMAL**	**100**	**t-Test_N**	**7.37E-08**	**Yes**
Copper	**20**	**NON-PARAMETRIC**	**100**	**45**	**NON-PARAMETRIC**	**100**	**WRS**	**6.34E-06**	**Yes**
Manganese	**20**	**NORMAL**	**100**	**45**	**NON-PARAMETRIC**	**100**	**WRS**	**8.04E-09**	**Yes**
Mercury	20	NON-PARAMETRIC	40	42	GAMMA	76.2	WRS	1.00	No
Nickel	**20**	**NORMAL**	**100**	**45**	**GAMMA**	**100**	**WRS**	**1.03E-08**	**Yes**
Selenium	**20**	**NON-PARAMETRIC**	**60**	**45**	**NON-PARAMETRIC**	**13.3**	**N/A**	**N/A**	**Yes[a]**
Tin	**20**	**NORMAL**	**0**	**43**	**NON-PARAMETRIC**	**20.9**	**N/A**	**N/A**	**Yes[a]**
Vanadium	**20**	**NORMAL**	**100**	**45**	**NORMAL**	**100**	**t-Test_N**	**2.59E-08**	**Yes**
Zinc	**20**	**NORMAL**	**100**	**45**	**NORMAL**	**100**	**t-Test_N**	**0.00696**	**Yes**
Total PAHs	**N/A**	**N/A**	**N/A**	**2**	**0**	**50**	**N/A**	**N/A**	**Yes[a]**
Total PCBs	**N/A**	**N/A**	**N/A**	**2**	**0**	**0**	**N/A**	**N/A**	**Yes[a]**

[a] Statistical comparisons to background cannot be performed. The analyte is retained for further evaluation.
WRS = Wilcoxon Rank Sum
t-Test_N = Student's t-test using normal data
N/A = Not applicable; site and/or background detection frequency less than 20%.
Bold = Analyte retained for further consideration in the next ECOPC selection step.

6

Table 7.6
Statistical Concentrations in Surface Soil (Non-PMJM) in the LWOEU

Analyte	Total Samples	UCL Recommended by ProUCL	Distribution Recommended by ProUCL	Mean Detected Concentration	Median Detected Concentration	75th Percentile	95th Percentile	UCL	UTL	MDC
Inorganics (mg/kg)										
Aluminum	74	95% Student's-t UCL	NORMAL	15,019	15,000	19,750	25,350	16,230	24,844	30,000
Antimony	60	97.5% Chebyshev (Mean, Sd) UCL	NON-PARAMETRIC	1.48	0.410	0.870	6.50	3.41	6.55	9.80
Barium	74	95% Student's-t UCL	NORMAL	146	141	170	225	155	214	240
Boron	46	95% Student's-t UCL	NORMAL	7.00	6.95	8.48	9.38	7.52	10.5	13.0
Chromium	74	95% Student's-t UCL	NORMAL	16.7	16.0	21.8	25.4	17.8	26.1	28.0
Copper	74	95% Student's-t UCL	NON-PARAMETRIC	19.0	16.0	18.5	28.1	22.6	30.0	170
Lithium	58	95% Student's-t UCL	NORMAL	12.5	13.0	15.8	20.0	13.5	19.9	22.0
Manganese	74	95% Student's-t UCL	NON-PARAMETRIC	375	344	390	610	408	636	1,200
Nickel	74	95% Approximate Gamma UCL	GAMMA	15.8	16.0	18.9	22.4	17.0	23.0	45.2
Thallium	74	97.5% Chebyshev (Mean, Sd) UCL	NON-PARAMETRIC	0.930	0.500	1.50	2.10	1.61	2.10	5.70
Tin	60	97.5% Chebyshev (Mean, Sd) UCL	NON-PARAMETRIC	5.16	1.35	2.03	25.7	15.4	29.1	85.9
Vanadium	74	95% Student's-t UCL	NORMAL	39.4	41.0	48.5	57.9	41.8	58.4	71.0
Zinc	74	95% Student's-t UCL	NORMAL	56.7	58.0	65.0	74.4	59.3	77.7	86.1

MDC = Maximum detected concentration or in some cases, maximum proxy result.
UCL = 95% upper confidence limit on the mean, unless the MDC < UCL, then MDC is used as the UCL.
UTL = 95% upper confidence limit on the 90th percentile value, unless the MDC< UTL than the MDC is used as the UTL.

62

Table 7.7
Upper-Bound Exposure Point Concentration Comparison to Limiting tESLs for Surface Soil (Non-PMJM) in the LWOEU

Analyte	Small Home Range Receptors			Large Home Range Receptors		
	EPC (95UTL)	Limiting ESL[a]	EPC>ESL?	EPC (95UCL)	Limiting ESL[b]	EPC>ESL?
Inorganics (mg/kg)						
Aluminum	24,800	50	**Yes**	16,200	N/A	N/A
Antimony	6.55	0.905	**Yes**	3.41	3.85	No
Barium	214	222	No	155	4,770	No
Boron	10.5	0.5	**Yes**	7.52	314	No
Chromium[c]	26.1	0.4	**Yes**	17.8	68.5	No
Copper	30.0	8.25	**Yes**	22.6	3,000	No
Lithium	19.9	2	**Yes**	13.5	2,560	No
Manganese	636	486	**Yes**	408	2,510	No
Nickel	23.0	0.431	**Yes**	17.0	1.86	**Yes**
Thallium	2.10	1	**Yes**	1.61	53.3	No
Tin	29.1	2.9	**Yes**	15.4	16.2	No
Vanadium	58.4	2	**Yes**	41.8	121	No
Zinc	77.7	0.646	**Yes**	59.3	431	No

[a]Threshold ESL (if available) for the plant, invertebrate, deer mouse, prairie dog, dove, or kestrel receptors.
[b]Threshold ESL (if available) for the coyote and mule deer receptors.
[c]The ESLs for chromium were developed using available toxicity data based on chromium III (birds) and chromium VI (plants, invertebrates, and mammals).
N/A = Not applicable; ESL not available (assessed in Section 10.0).
Bold = Analyte retained for further consideration in the next ECOPC selection step.

63

Table 7.8

Upper-Bound Exposure Point Concentration Comparison to Receptor-Specific ESLs for Small Home Range Receptors in the LWOEU Surface Soil (Non-PMJM)

Analyte	Small Home Range Receptor UTL	Receptor-Specific ESLs[a]							
		Terrestrial Plant	Terrestrial Invertebrate	American Kestrel	Mourning Dove (herbivore)	Mourning Dove (insectivore)	Deer Mouse (herbivore)	Deer Mouse (insectivore)	Prairie Dog
Inorganics (mg/kg)									
Aluminum	24,800	**50**	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Antimony	6.55	**5**	78	N/A	N/A	N/A	9.89	**0.905**	18.7
Boron	10.5	**0.5**	N/A	167	30.3	115	62.1	422	237
Chromium	26.1	**1**	**0.4**	**14.2**	**24.6**	**1.34**	281	**15.9**	703
Copper	30.0	100	50.0	164	**28.8**	**8.25**	295	605	838
Lithium	19.9	**2**	N/A	N/A	N/A	N/A	1,880	610	3,180
Manganese	636	**500**	N/A	9,920	1,030	2,630	**486**	4,080	1,519
Nickel	23.0	30	200	89.9	320	**7.84**	**16.4**	**0.431**	38.3
Thallium	2.10	**1**	N/A	N/A	N/A	N/A	312	12.5	350
Tin	29.1	50	N/A	**19**	**26.1**	**2.9**	45	**3.77**	80.6
Vanadium	58.4	**2**	N/A	1,510	503	274	63.7	**29.9**	83.5
Zinc	77.7	**50**	200	113	109	**0.646**	171	**5.29**	1,170

[a]Threshold ESL (if available).

N/A = Not applicable; ESL not available (assessed in Section 10.0).

Bold = Receptors of potential concern.

64

Table 7.9

Upper-Bound Exposure Point Concentration Comparison to Receptor-Specific ESLs for Large Home Range Receptors in the LWOEU Surface Soil (Non-PMJM)

Analyte	Large Home Range Receptor 95th UCL	Receptor-Specific ESLs[a]			
		Mule Deer	Coyote (carnivore)	Coyote (generalist)	Coyote (insectivore)
Inorganics (mg/kg)					
Nickel	17.0	124	90.9	**6.02**	**1.86**

[a]Threshold ESL (if available).

Bold = Receptors of potential concern.

Table 7.10
Summary of ECOPC Screening Steps for Surface Soil Non-PMJM Receptors in the LWOEU

Analyte	Exceed Any NOAEL ESL?	Detection Frequency >5%?	Exceeds Background?	Upper Bound EPC > Limiting ESL?	Professional Judgment - Retain?	ECOPC?	Receptor(s) of Potential Concern
Inorganics							
Aluminum	Yes	Yes	Yes	Yes	No	No	--
Ammonia	No	--	--	--	--	No	--
Antimony	Yes	Yes	N/A	Yes	No	No	--
Arsenic	Yes	Yes	No	--	--	No	--
Barium	Yes	Yes	Yes	No	--	No	--
Beryllium	No	--	--	--	--	No	--
Boron	Yes	Yes	N/A	Yes	No	No	--
Cadmium	Yes	Yes	No	--	--	No	--
Calcium	UT	--	--	--	--	No	--
Cesium	UT	--	--	--	--	No	--
Chromium	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Terrestrial plant Terrestrial invertebrate American kestrel Mourning dove (herbivore) Mourning dove (insectivore) Deer mouse (insectivore)**
Cobalt	Yes	Yes	No	--	--	No	--
Copper	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Mourning dove (herbivore) Mourning dove (insectivore)**
Iron	UT	--	--	--	--	No	--
Lead	Yes	Yes	No	--	--	No	--
Lithium	Yes	Yes	Yes	Yes	No	No	--
Magnesium	UT	--	--	--	--	No	--
Manganese	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Terrestrial plant Deer mouse (herbivore)**
Mercury	Yes	Yes	No	--	--	No	--
Molybdenum	No	--	--	--	--	No	--
Nickel	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Mourning dove (insectivore) Deer mouse (herbivore) Deer mouse (insectivore) Coyote (generalist) Coyote (insectivore)**
Nitrate/Nitrite	No	--	--	--	--	No	--
Potassium	UT	--	--	--	--	No	--
Selenium	Yes	Yes	No	--	--	No	--
Silica	UT	--	--	--	--	No	--
Silicon	UT	--	--	--	--	No	--
Silver	No	--	--	--	--	No	--
Sodium	UT	--	--	--	--	No	--
Strontium	No	--	--	--	--	No	--
Thallium	**Yes**	**Yes**	**N/A**	**Yes**	**Yes**	**Yes**	**Terrestrial plant**
Tin	**Yes**	**Yes**	**N/A**	**Yes**	**Yes**	**Yes**	**American kestrel Mourning dove (herbivore) Mourning dove (insectivore) Deer mouse (insectivore)**
Titanium	UT	--	--	--	--	No	--
Vanadium	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Terrestrial plant Deer mouse (insectivore)**
Zinc	Yes	Yes	Yes	Yes	No	No	--
Organics							
Benzoic Acid	UT	--	--	--	--	No	--
bis(2-ethylhexyl)phthalate	No	--	--	--	--	No	--
Chrysene	UT	--	--	--	--	No	--
Fluoranthene	UT	--	--	--	--	No	--
Phenanthrene	UT	--	--	--	--	No	--
Pyrene	UT	--	--	--	--	No	--
Radionuclides							

65

Table 7.10
Summary of ECOPC Screening Steps for Surface Soil Non-PMJM Receptors in the LWOEU

Analyte	Exceed Any NOAEL ESL?	Detection Frequency >5%?	Exceeds Background?	Upper Bound EPC > Limiting ESL	Professional Judgment - Retain?	ECOPC?	Receptor(s) of Potential Concern
Americium-241	No	--	--	--	--	No	--
Cesium-134	UT	--	--	--	--	No	--
Cesium-137	No	--	--	--	--	No	--
Gross Alpha	UT	--	--	--	--	No	--
Gross Beta	UT	--	--	--	--	No	--
Plutonium-238	UT	--	--	--	--	No	--
Plutonium-239/240	No	--	--	--	--	No	--
Radium-226	No	--	--	--	--	No	--
Radium-228	No	--	--	--	--	No	--
Strontium-89/90	No	--	--	--	--	No	--
Uranium-233/234	No	--	--	--	--	No	--
Uranium-235	No	--	--	--	--	No	--
Uranium-238	No	--	--	--	--	No	--

[a] Based on results of statistical analysis at the 0.1 level of significance.
N/A = Not applicable; background comparison could not be conducted.
UT = Uncertain toxicity; no ESL available (assessed in Section 10.0).
-- = Screen not preformed because analyte was eliminated from further consideration in a previous ECOPC selection step.
Bold = Analyte retained as an ECOPC for risk characterization.

66

Table 7.11
Summary of ECOPC Screening Steps for Surface Soil PMJM Receptors in the LWOEU

Analyte	Exceed PMJM NOAEL ESL?	Exceeds Background?	Professional Judgment - Retain?	ECOPC
Inorganics				
Aluminum	UT	--	--	No
Antimony	No	--	--	No
Arsenic	Yes	No	--	No
Barium	No	--	--	No
Beryllium	No	--	--	No
Boron	No	--	--	No
Cadmium	No	--	--	No
Calcium	UT	--	--	No
Cesium	UT	--	--	No
Chromium	**Yes**	**Yes**	**Yes**	**Yes**
Cobalt	No	--	--	No
Copper	**Yes**	**Yes**	**Yes**	**Yes**
Iron	UT	--	--	No
Lead	No	--	--	No
Lithium	No	--	--	No
Magnesium	UT	--	--	No
Manganese	**Yes**	**Yes**	**Yes**	**Yes**
Mercury	Yes	No	--	No
Molybdenum	No	--	--	No
Nickel	**Yes**	**Yes**	**Yes**	**Yes**
Potassium	UT	--	--	No
Selenium	**Yes**	**Yes**	**Yes**	**Yes**
Silica	UT	--	--	No
Silicon	UT	--	--	No
Silver	UT	--	--	No
Sodium	UT	--	--	No
Strontium	No	--	--	No
Thallium	No	--	--	No
Tin	**Yes**	**N/A**	**Yes**	**Yes**
Titanium	UT	--	--	No
Vanadium	**Yes**	**Yes**	**Yes**	**Yes**
Zinc	**Yes**	**Yes**	**Yes**	**Yes**
Organics				
Benzoic Acid	UT	--	--	No
Radionuclides				
Americium-241	No	--	--	No
Cesium-134	UT	--	--	No
Cesium-137	No	--	--	No
Gross Alpha	UT	--	--	No
Gross Beta	UT	--	--	No
Plutonium-239/240	No	--	--	No
Radium-226	No	--	--	No
Radium-228	No	--	--	No
Strontium-89/90	No	--	--	No
Uranium-233/234	No	--	--	No
Uranium-235	No	--	--	No
Uranium-238	No	--	--	No

N/A = Not applicable; background comparison could not be conducted.
UT = Uncertain toxicity; no ESL available (assessed in Section 10.0).
-- = Screen not preformed because analyte was eliminated from further consideration in a previous ECOPC selection step.
Bold = Analyte retained as an ECOPC for risk characterization.

67

Table 7.12
Comparison of MDCs in Subsurface Soil to NOAEL ESLs for Burrowing Receptors in the LWOEU

Analyte	MDC	Prairie Dog NOAEL ESL	MDC>ESL?
Inorganics (mg/kg)			
Aluminum	37,000	N/A	UT
Antimony	**20.2**	**18.7**	**Yes**
Arsenic	**15**	**9.35**	**Yes**
Barium	220	3,220	No
Beryllium	1.60	211	No
Boron	11	237	No
Cadmium	1.80	198	No
Calcium	98,200	N/A	UT
Cesium	2.65	N/A	UT
Chromium[a]	73.9	703	No
Cobalt	17.1	2,460	No
Copper	30	838	No
Iron	35,800	N/A	UT
Lead	1,400	1,850	No
Lithium	26	3,180	No
Magnesium	6,570	N/A	UT
Manganese	793	1,520	No
Mercury	0.130	3.15	No
Molybdenum	6.50	27.1	No
Nickel	**49.9**	**38.3**	**Yes**
Nitrate / Nitrite[b]	0.900	16,200	No
Potassium	5,400	N/A	UT
Selenium	1	2.80	No
Silica	1,400	N/A	UT
Silicon	383	N/A	UT
Silver	0.120	N/A	UT
Sodium	444	N/A	UT
Strontium	401	3,520	No
Thallium	3.10	204	No
Tin	22.3	80.6	No
Titanium	370	N/A	UT
Uranium	1.80	1,230	No
Vanadium	**110**	**83.5**	**Yes**
Zinc	97	1,170	No
Organics (µg/kg)			
Acetone	30	248,000	No
Benzoic Acid	260	N/A	UT
Di-n-butylphthalate	55	4.06E+07	No
Methylene Chloride	23	210,000	No
Tetrachloroethene	2	72,500	No
Toluene	130	1.22E+06	No
2,3,7,8-TCDD TEQ[c]	0.00118	0.160	No
Xylene[d]	1.60	112,000	No
Radionuclides (pCi/g)			
Americium-241	0.390	3,890	No

68

Table 7.12
Comparison of MDCs in Subsurface Soil to NOAEL ESLs for Burrowing Receptors in the LWOEU

Analyte	MDC	Prairie Dog NOAEL ESL	MDC>ESL?
Cesium-134	0.0500	N/A	UT
Cesium-137	0.0800	20.8	No
Gross Alpha	38.9	N/A	UT
Gross Beta	29	N/A	UT
Plutonium-238	0.0110	N/A	UT
Plutonium-239/240	0.736	6,110	No
Radium-226	2.08	50.6	No
Radium-228	1.57	43.9	No
Strontium-89/90	0.0304	22.5	No
Uranium-233/234	1.78	4,980	No
Uranium-235	0.0741	2,770	No
Uranium-238	1.68	1,580	No

[a]The ESLs for chromium were developed using available toxicity data based on chromium III (birds) and chromium VI (plants, invertebrates, and mammals).

[b]The ESL for nitrate is used.

[c]The TEQ for 2,3,7,8-TCDD is calculated in Table 1.9 and the ESL for 2,3,7,8-TCDD is used in the ESL screen.

[d]The value for total xylene is used.

N/A = Indicates no ESL was available for that ECOI/receptor pair.

UT = Uncertain toxicity; no ESL available (assessed in Section 10.0).

Bold = Analyte retained for further consideration in the next ECOPC selection step.

69

Table 7.13
Statistical Distribution and Comparison to Background for Subsurface Soil in the LWOEU

Analyte	Statistical Distribution Testing Results						Background Comparison		
	Background			LWOEU					
	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Test	1 - p	Retain as ECOI?
Inorganics (mg/kg)									
Antimony	**28**	**NONPARAMETRIC**	**7**	**46**	**NONPARAMETRIC**	**35**	**N/A**	**N/A**	**Yes[a]**
Arsenic	**45**	**NONPARAMETRIC**	**93**	**47**	**NONPARAMETRIC**	**100**	**WRS**	**0.010**	**Yes**
Nickel	44	GAMMA	100	47	NONPARAMETRIC	100	WRS	0.574	No
Vanadium	**45**	**NORMAL**	**98**	**47**	**NONPARAMETRIC**	**100**	**WRS**	**0.002**	**Yes**

[a] Statistical comparisons to background cannot be performed. The analyte is retained as an ECOI for further evaluation.
WRS = Wilcoxon Rank Sum
N/A = Not applicable; site and/or background detection frequency less than 20%.
Bold = Analyte retained for further consideration in the next ECOPC selection step.

Table 7.14
Statistical Concentrations in Subsurface Soil in the LWOEU

Analyte	Units	Total Samples	UCL Recommended by ProUCL	Distribution Recommended by ProUCL	Mean Detected Concentration	Median Detected Concentration	75th Percentile	95th Percentile	UCL	UTL	MDC
Antimony	mg/kg	46	99% Chebyshev (Mean, Sd) UCL	NON-PARAMETRIC	2.44	0.435	3.21	10.2	8.40	10.7	20.2
Arsenic	mg/kg	47	95% Student's-t UCL	NON-PARAMETRIC	5.96	6.30	7.10	10.1	6.60	10.4	15.0
Vanadium	mg/kg	47	95% Student's-t UCL	NON-PARAMETRIC	44.9	49.0	56.0	65.7	49.6	66.0	110

MDC = Maximum detected concentration, or in some cases, maxiumum proxy result.
UCL = 95% upper confidence limit on the mean, unless the MDC < UCL, then MDC is used as the UCL.
UTL = 95% upper confidence limit on the 90th percentile value, unless the MDC< UTL than the MDC is used as the UTL.

Table 7.15
Upper-Bound Exposure Point Concentration Comparison to tESLs in the LWOEU Subsurface Soil

Analyte	Burrowing Receptors		
	EPC (95 UTL)	tESL[a]	EPC>ESL?
Inorganics (mg/kg)			
Antimony	**10.7**	**1.87**	**Yes**
Arsenic	10.4	35.9	No
Vanadium	66.0	83.5	No

[a]Threshold ESL (if available) for the prairie dog receptor.
Bold = Analyte retained for further consideration in the next ECOPC selection step.

12

Table 7.16
Summary of ECOPC Screening Steps for Subsurface Soil in the LWOEU

Analyte	Exceed Any NOAEL ESL	Frequency of Detection >5%	Exceeds Background?[a]	Upper Bound EPC > Limiting ESL?	Professional Judgment Retain?	Retain as ECOPC?
Inorganics						
Aluminum	UT	--	--	--	--	No
Antimony	Yes	Yes	N/A	Yes	No	No
Arsenic	Yes	Yes	Yes	No	No	No
Barium	No	--	--	--	--	No
Beryllium	No	--	--	--	--	No
Boron	No	--	--	--	--	No
Cadmium	No	--	--	--	--	No
Calcium	UT	--	--	--	--	No
Cesium	UT	--	--	--	--	No
Chromium	No	--	--	--	--	No
Cobalt	No	--	--	--	--	No
Copper	No	--	--	--	--	No
Iron	UT	--	--	--	--	No
Lead	No	--	--	--	--	No
Lithium	No	--	--	--	--	No
Magnesium	UT	--	--	--	--	No
Manganese	No	--	--	--	--	No
Mercury	No	--	--	--	--	No
Molybdenum	No	--	--	--	--	No
Nickel	Yes	Yes	No	--	--	No
Nitrate / Nitrite	No	--	--	--	--	No
Potassium	UT	--	--	--	--	No
Selenium	No	--	--	--	--	No
Silica	UT	--	--	--	--	No
Silicon	UT	--	--	--	--	No
Silver	UT	--	--	--	--	No
Sodium	UT	--	--	--	--	No
Strontium	No	--	--	--	--	No
Thallium	No	--	--	--	--	No
Tin	No	--	--	--	--	No
Titanium	UT	--	--	--	--	No
Uranium	No	--	--	--	--	No
Vanadium	Yes	Yes	Yes	No	--	No
Zinc	No	--	--	--	--	No
Organics						
Acetone	No	--	--	--	--	No
Benzoic Acid	UT	--	--	--	--	No
Di-n-butylphthalate	No	--	--	--	--	No
Methylene Chloride	No	--	--	--	--	No
Tetrachloroethene	No	--	--	--	--	No
Toluene	No	--	--	--	--	No
Total Dioxins	No	--	--	--	--	No
Xylene	No	--	--	--	--	No
Radionuclides						
Americium-241	No	--	--	--	--	No

73

Table 7.16
Summary of ECOPC Screening Steps for Subsurface Soil in the LWOEU

Analyte	Exceed Any NOAEL ESL?	Frequency of Detection >5%	Exceeds Background?[a]	Upper Bound EPC > Limiting ESL?	Professional Judgment - Retain?	Retain as ECOPC?
Cesium-134	UT	--	--	--	--	No
Cesium-137	No	--	--	--	--	No
Gross Alpha	UT	--	--	--	--	No
Gross Beta	UT	--	--	--	--	No
Plutonium-238	UT	--	--	--	--	No
Plutonium-239/240	No	--	--	--	--	No
Radium-226	No	--	--	--	--	No
Radium-228	No	--	--	--	--	No
Strontium-89/90	No	--	--	--	--	No
Uranium-233/234	No	--	--	--	--	No
Uranium-235	No	--	--	--	--	No
Uranium-238	No	--	--	--	--	No

[a] Based on results of statistical analysis at the 0.1 level of significance.
N/A = Not applicable; background comparison could not be conducted.
UT = Uncertain toxicity; no ESL available (assessed in Section 10.0).
-- = Screen not preformed because analyte was eliminated from further consideration in a previous ECOPC selection step.

74

Table 8.1
Summary of ECOPC/Receptor Pairs

ECOPC	Receptors of Potential Concern
Surface Soil	
Chromium	Terrestrial plant Terrestrial invertebrate American kestrel Mourning dove (herbivore) Mourning dove (insectivore) Deer mouse (insectivore)
Copper	Mourning Dove (herbivore) Mourning Dove (insectivore)
Manganese	Terrestrial plant Deer mouse (herbivore)
Nickel	Mourning dove (insectivore) Deer mouse (herbivore) Deer mouse (insectivore) Coyote (generalist) Coyote (insectivore)
Thallium	Terrestrial plant
Tin	American kestrel Mourning dove (herbivore) Mourning dove (insectivore) Deer mouse (insectivore)
Vanadium	Terrestrial plant Deer mouse (insectivore)
Surface Soil-PMJM	
Chromium	PMJM
Copper	PMJM
Manganese	PMJM
Nickel	PMJM
Selenium	PMJM
Tin	PMJM
Vanadium	PMJM
Zinc	PMJM
Subsurface Soil	
None	None

75

Table 8.2
Surface Soil Exposure Point Concentrations for Non-PMJM Receptors

ECOPC	Tier I Exposure Point Concentrations (mg/kg)		Tier II Exposure Point Concentrations (mg/kg)	
	95th UTL	95th UCL	95th UTL	95th UCL
Inorganics				
Chromium	26.1	17.8	15.4	13.8
Copper	30.0	22.6	18.7	16.9
Manganese	636	408	364	340
Nickel	23.0	17.0	15.6	14.3
Thallium	2.10	1.61	0.431	0.354
Vanadium	58.4	41.8	39.1	35.6

Table 8.3
Surface Soil Exposure Point Concentrations in PMJM Patches

Analyte[a]	Number of Samples	Number of Detects	Frequency of Detection (%)	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	Arithmetic Mean Concentration (mg/kg)	95th UCL (mg/kg)
Patch 22							
Chromium	2	2	100	18	22	20	N/A
Manganese	2	2	100	330	460	395	N/A
Nickel	2	2	100	18	19	18.5	N/A
Vanadium	2	2	100	44	49	46.5	N/A
Zinc	2	2	100	59	66	62.5	N/A
Patch 23							
Chromium	39	39	100	8.4	28	19.6	21.0
Copper	39	39	100	7.6	170	22.1	29.0
Manganese	39	39	100	270	1,200	420	475
Nickel	39	39	100	8.1	25	16.9	17.9
Selenium	39	5	12.8	0.28	2	0.522	0.6
Tin	38	8	21.1	1.7	32.7	2.24	3.6
Vanadium	39	39	100	20	59	43.0	45.5
Zinc	39	39	100	19	84	58.0	61.4
Patch 24							
Chromium	1	1	100	14	14	14	N/A
Manganese	1	1	100	380	380	380	N/A
Nickel	1	1	100	15	15	15	N/A
Vanadium	1	1	100	45	45	45	N/A
Zinc	1	1	100	55	55	55	N/A
Patch 25							
Chromium	1	1	100	13.6	13.6	13.6	N/A
Manganese	1	1	100	330	330	330	N/A
Nickel	1	1	100	13.4	13.4	13.4	N/A
Tin	1	1	100	25.5	25.5	25.5	N/A
Vanadium	1	1	100	35.1	35.1	35.1	N/A
Zinc	1	1	100	52	52	52	N/A
Patch 27							
Chromium	2	2	100	7.2	7.9	7.55	N/A
Manganese	2	2	100	330	596	463	N/A
Nickel	2	2	100	10.1	45.2	27.7	N/A
Selenium	2	1	50	0.31	0.31	0.213	N/A
Vanadium	2	2	100	25.7	33.8	29.8	N/A
Zinc	2	2	100	46.3	86.1	66.2	N/A

Notes:

[a]Analytes listed were detected at least once in a given patch. Patch 26 and 28 did not have any ECOPCs.

N/A = Calculated UCLs were greater than the maximum detected concentration or could not be calculated due to low number of samples (n < 5).

ECOPCs shown on this table are only those that have patch-specific MDCs > ESL

Table 8.4
Surface Water Exposure Point Concentrations for Non-PMJM and PMJM Receptors

ECOPC	UTL	UCL
Inorganics (mg/L)		
Chromium	0.004	0.004
Copper	0.007	0.005
Manganese	0.57	0.162
Nickel	0.01	0.006
Selenium	0.003	0.004
Thallium	0.003	0.007
Tin	0.019	0.009
Vanadium	0.008	0.006
Zinc	0.033	0.015

78

Table 8.5
Receptor-Specific Exposure Parameters

Receptor	Body Weight (kg)	Body Weight Reference	Percentage of Diet: Plant Tissue	Percentage of Diet: Invertebrate Tissue	Percentage of Diet: Bird or Mammal Tissue	Dietary Reference	Food Ingestion Rate (kg/kg BW day^{-1})	Ingestion Rate Reference	Water Ingestion Rate (L/kg BW day^{-1})	Ingestion Rate Reference	Percentage of Diet as Soil	Soil Ingestion Reference
Non-Wildlife Terrestrial Receptors												
Terrestrial Plants	N/A											
Terrestrial Invertebrates	N/A											
Vertebrate Receptors - Birds												
American kestrel	0.116	Brown and Amadon (1968) - Average value	0	20	80	Generalized Diet from several studies presented in the Watershed ERA DOE (1996)	0.092	Kolpin et al. (1980)	0.12	EPA (1993) - Estimated using model for all birds - Calder and Braun (1983)	5	Assumed value based on conservative estimates for carnivores
Mourning Dove (herbivore)	0.113	Average of adult values from CalEPA (2004) Online Database	100	0	0	Cowan (1952)	0.23	EPA (2003)	0.12	EPA (1993) - Estimated using model for all birds - Calder and Braun (1983)	9.3	Beyer et al. (1994) - Wild turkey used as a surrogate.
Mourning Dove (insectivore)	0.113	Average of adult values from CalEPA (2004) Online Database	0	100	0	Generalized Diet	0.23	EPA (2003)	0.12	EPA (1993) - Estimated using model for all birds - Calder and Braun (1983)	9.3	Beyer et al. (1994) - Wild turkey used as a surrogate.
Vertebrate Receptors - Mammals												
Preble's Meadow Jumping Mouse	0.019	Morrison and Ryser (1962)	70	30	0	Estimated from Whitacker (1972)	0.17	EPA (1993) - Estimated- Nagy (1987) Rodent Model	0.15	EPA (1993) - Estimated using model for all mammals - Calder and Braun (1983)	2.4	Beyer et al. (1994) - Meadow Vole used as a conservative surrogate
Deer Mouse (herbivore)	0.0187	Flake (1973)	100	0	0	Generalized Diet	0.111	Cronin and Bradley (1988)	0.19	Ross (1930); Dice (1922) as cited in EPA (1993).	2	Beyer et al. (1994)

Table 8.5
Receptor-Specific Exposure Parameters

Receptor	Body Weight (kg)	Body Weight Reference	Percentage of Diet				Food Ingestion Rate (kg/kg BW day⁻¹)	Ingestion Rate Reference	Water Ingestion Rate (L/kg BW day⁻¹)	Ingestion Rate Reference	Percentage of Diet as Soil	Soil Ingestion Reference
			Plant Tissue	Invertebrate Tissue	Bird or Mammal Tissue	Dietary Reference						
Deer Mouse (insectivore)	0.0187	Flake (1973)	0	100	0	Generalized Diet	0.065	Cronin and Bradley (1988)	0.19	Ross (1930); Dice (1922) as cited in USEPA 1993.	2	Beyer et al. (1994)
Coyote (generalist)	12.75	Bekoff (1977) - Average of male and female weights	0	25	75	Generalized Diet	0.015	Gier (1975)	0.08	EPA (1993) - Estimated using model for all mammals - Calder and Braun (1983)	5	Beyer et al. (1994) - High end estimate for Red Fox
Coyote (insectivore)	12.75	Bekoff (1977) - Average of male and female weights	0	100	0	Generalized Diet	0.015	Gier (1975)	0.08	EPA (1993) - Estimated using model for all mammals - Calder and Braun (1983)	2.8	Beyer et al. (1994) - Red Fox

Receptor parameters for all receptors with the exception of the prairie dog and mourning dove were taken from the Watershed Risk Assessment (DOE 1996) and referenced to the original source.
All receptor parameters are estimates of central tendency except where noted.
All values are presented in a dry weight basis.
N/A = Not applicable.

Table 8.6
Receptor-Specific Intake Estimates

Intake Estimates (mg/kg BW day)						
	Plant Tissue	Invertebrate Tissue	Mammal Tissue	Soil	Surface Water	Total
Default Exposure Estimates						
Chromium						
Mourning Dove - Herbivore						
Tier 1 UTL	0.504	N/A	N/A	0.558	4.80E-04	1.06
Tier 2 UTL	0.298	N/A	N/A	0.329	4.80E-04	0.627
Mourning Dove - Insectivore						
Tier 1 UTL	N/A	19.0	N/A	0.558	4.80E-04	19.5
Tier 2 UTL	N/A	11.2	N/A	0.329	4.80E-04	11.5
American Kestrel						
Tier 1 UTL	N/A	1.52	0.180	0.120	4.80E-04	1.82
Tier 2 UTL	N/A	0.896	0.122	0.071	4.80E-04	1.09
Deer Mouse - Insectivore						
Tier 1 UTL	N/A	5.36	N/A	0.034	7.60E-04	5.40
Tier 2 UTL	N/A	3.17	N/A	0.020	7.60E-04	3.19
Copper						
Mourning Dove - Herbivore						
Tier 1 UTL	1.71	N/A	N/A	0.642	8.40E-04	2.36
Tier 2 UTL	1.42	N/A	N/A	0.400	8.40E-04	1.82
Mourning Dove - Insectivore						
Tier 1 UTL	N/A	3.01	N/A	0.642	8.40E-04	3.66
Tier 2 UTL	N/A	2.66	N/A	0.400	8.40E-04	3.06
Manganese						
Deer Mouse - Herbivore						
Tier 1 UTL	16.5	N/A	N/A	1.41	0.108	18.0
Tier 2 UTL	9.46	N/A	N/A	0.809	0.108	10.4
Nickel						
Mourning Dove - Insectivore						
Tier 1 UTL	N/A	25.0	N/A	0.492	0.001	25.5
Tier 2 UTL	N/A	17.0	N/A	0.334	0.001	17.3
Deer Mouse - Herbivore						
Tier 1 UTL	0.125	N/A	N/A	0.051	0.002	0.178
Tier 2 UTL	0.094	N/A	N/A	0.035	0.002	0.130
Deer Mouse - Insectivore						
Tier 1 UTL	N/A	7.07	N/A	0.030	0.002	7.10
Tier 2 UTL	N/A	4.80	N/A	0.020	0.002	4.82
Coyote - Generalist						
Tier 1 UCL	N/A	0.302	0.033	0.013	4.80E-04	0.348
Tier 2 UCL	N/A	0.254	0.030	0.011	4.80E-04	0.295
Coyote - Insectivore						
Tier 1 UCL	N/A	1.21	N/A	0.007	4.80E-04	1.21
Tier 2 UCL	N/A	1.01	N/A	0.006	4.80E-04	1.02
Tin						
Mourning Dove - Herbivore						
Tier 1 UTL	0.201	N/A	N/A	0.622	0.002	0.826
Tier 2 UTL	0.088	N/A	N/A	0.273	0.002	0.364
Mourning Dove - Insectivore						
Tier 1 UTL	N/A	6.69	N/A	0.622	0.002	7.32
Tier 2 UTL	N/A	2.94	N/A	0.273	0.002	3.21
American Kestrel						
Tier 1 UTL	N/A	0.535	0.450	0.134	0.002	1.12

81

Table 8.6
Receptor-Specific Intake Estimates

	Intake Estimates (mg/kg BW day)					
	Plant Tissue	**Invertebrate Tissue**	**Mammal Tissue**	**Soil**	**Surface Water**	**Total**
Default Exposure Estimates						
Tier 2 UTL	N/A	0.235	0.197	0.059	0.002	0.493
Deer Mouse - Insectivore						
Tier 1 UTL	N/A	1.89	N/A	0.038	0.004	1.93
Tier 2 UTL	N/A	0.830	N/A	0.017	0.004	0.850
Vanadium						
Deer Mouse - Insectivore						
Tier 1 UTL	N/A	0.334	N/A	0.076	0.002	0.411
Tier 2 UTL	N/A	0.224	N/A	0.051	0.002	0.276

N/A = Not applicable.

82

Table 8.7
PMJM Intake Estimates

	Intake Estimates (mg/kg BW day)					
	Plant Tissue	Invertebrate Tissue	Mammal Tissue	Soil	Surface Water	Total
Default Exposure Estimates						
Chromium						
Patch 22						
UCL[a]	0.220	3.55	N/A	0.090	0.011	3.87
Patch 23						
UCL	0.210	3.39	N/A	0.086	6.00E-04	3.68
Copper						
Patch 23						
UCL	0.876	0.66	N/A	0.118	2.43E-02	1.68
Manganese						
Patch 22						
UCL[a]	12.8	7.50	N/A	1.88	0.135	22.3
Patch 23						
UCL	13.2	7.66	N/A	1.94	0.024	22.9
Patch 27						
UCL[a]	16.6	8.95	N/A	2.43	0.135	28.1
Nickel						
Patch 22						
UCL[a]	0.116	4.58	N/A	0.078	0.003	4.78
Patch 23						
UCL	0.111	4.32	N/A	0.073	9.00E-04	4.50
Patch 24						
UCL[a]	0.098	3.62	N/A	0.061	0.003	3.78
Patch 27						
UCL[a]	0.223	10.9	N/A	0.184	0.003	11.3
Selenium						
Patch 23						
UCL	0.034	0.033	N/A	0.002	6.00E-04	0.070
Tin						
Patch 23						
UCL	0.013	0.184	N/A	0.015	0.001	0.212
Patch 25						
UCL[a]	0.091	1.30	N/A	0.104	0.004	1.50
Vanadium						
Patch 22						
UCL[a]	0.057	0.220	N/A	0.200	0.011	0.487
Patch 23						
UCL	0.053	0.204	N/A	0.186	9.00E-04	0.443
Zinc						
Patch 23						
UCL	5.63	16.8	N/A	0.251	0.002	22.7
Patch 27						
UCL[a]	6.79	18.8	N/A	0.351	0.041	26.0

N/A = Not applicable.

[a]Not enough samples were available to calculate a UCL. The MDC was used as a default.

83

64

Table 9.1
TRVs for Terrestrial Plant and Invertebrate Receptors

ECOPC	Soil Concentration (mg/kg)	Endpoint	Effect Measured/Observed	Reference	Notes
Terrestrial Plants					
Chromium	1	Screening ESL	Value was not based on any specific study.	Efroymson et al. 1997a	Low confidence in value.
Manganese	500	Screening ESL	Reduction in leaf and stem weights of bush beans	Efroymson et al. 1997a	Low confidence in value.
Thallium	1	Screening ESL	Value based on unspecified effects.	Efroymson et al. 1997a	Low confidence in value.
Vanadium	2	Screening ESL	Value was not based on any specific study.	Efroymson et al. 1997a	Low confidence in value.
Terrestrial Invertebrates					
Chromium	0.4	Screening ESL	Value based on lowest concentration tested and then adjusted by an uncertainty factor of 5.	Efroymson et al. 1997b	Low confidence in value.

ᘔ5

Table 9.2
TRVs for Terrestrial Vertebrate Receptors

ECOPC	NOAEL (mg/kg day)	NOAEL Endpoint	Lowest Bounded LOAEL (mg/kg day)	LOAEL Endpoint	TRV Source	Uncertainty Factor	Final NOAEL (mg/kg day)	Threshold (mg/kg day)	Rationale For Calculation	TRV Confidence
Birds										
Chromium III	1	No effect on black duckling survival	5	Reduction in black duckling survival	Sample et al. (1996)	1	1	N/A	Threshold not provided in CRA Methodology	High
Chromium VI	*No Values Available*									NA
Copper	2.3	No effects noted	52.3	Increase in chicken gizzard erosion	PRC (1994)	1	2.3	11	The nature of the effect is not likely to cause a significant effect on growth, reproduction, or survival. Thus, the data satisfy the requirements described in the text for calculating a threshold.	High
Nickel	1.38	No increase in tremors or toe and leg joint edema	55.26	Increase in tremors and toe and knee joint edema in mallard	PRC (1994)	1	1.38	8.7	The nature of the effect is not likely to cause a significant effect on growth, reproduction or survival. Thus, the data satisfy the requirements described in the text for calculating a threshold.	High
Mammals										
Chromium III	2,737	No effects on rat reproduction and life span	NA	No effects at the highest study dose	Sample et al. (1996)	1	2,737	NA	Theshold not provided in CRA Methodology.	High
Chromium VI	3.28	No effects on rat body weight or food consumption	13.14	Increased mortality in rats	Sample et al. (1996)	1	3.28	N/A	Theshold not provided in CRA Methodology.	High
Manganese	13.7	No change in mouse testicle weight	159.1	Decrease in mouse testicle weight	PRC (1994)	1	13.7	N/A	Theshold not provided in CRA Methodology.	High
Nickel	0.133	NOAEL was estimated from LOAEL	1.33	Increase in pup mortality in rats	PRC (1994)	1	0.133	N/A	NOAEL was estimated from LOAEL	High
Selenium	0.05	No increase in liver lesions in mice	1.21	Decrease in mouse reproductive success	PRC (1994)	1	0.05	N/A	The effects were noted to be in the mid-range, therefore, no threshold was calculated	High

96

Table 9.2
TRVs for Terrestrial Vertebrate Receptors

ECOPC	NOAEL (mg/kg day)	NOAEL Endpoint	Lowest Bounded LOAEL (mg/kg day)	LOAEL Endpoint	TRV Source	Uncertainty Factor	Final NOAEL (mg/kg day)	Threshold (mg/kg day)	Rationale For Calculation	TRV Confidence
Tin (Butyltins)	0.25	No systemic effects	15	Midrange of effects less than mortality	PRC (1994)	1	0.25	N/A	Theshold not provided in CRA Methodology.	High
Vanadium	0.21	NOAEL estimated from LOAEL	2.1	Significant reproductive effects in rats	Sample et al. (1996)	1	0.21	N/A	NOAEL was estimated from the LOAEL.	High
Zinc	9.61	NOAEL was estimated from LOAEL	411.4	Increase in fetal developmental effects in rats	PRC (1994)	1	9.61	N/A	NOAEL was estimated from LOAEL	High

Threshold TRVs were independently calculated using the procedures outline in the CRA Methodology, Section 3.1.4.
<u>TRV Confidence:</u>
NA = No TRV has been identified or the TRV has been deemed unacceptable for use in ECOPC selection.
Low = TRVs that have data for only one species looking at one endpoint (non-mortality) and from one primary literature source.
Moderate = TRVs that have multiple primary literature sources looking at one endpoint (non-mortality or mortality) but with only one species evaluated.
Good = For TRVs that have either multiple species with one endpoint from multiple studies or those TRVs with multiple species and multiple endpoints from only one study.
High = For TRVs that have multiple study sources looking at multiple endpoints and more than one species.
Very High = All EcoSSLs (EPA 2003a) will be assigned this level of confidence by default.

Table 10.1
Hazard Quotient Summary For Non-PMJM Receptors

ECOPC	Receptor	BAF	EPC	Hazard Quotients (HQs) Based on Default TRVs	Hazard Quotients (HQs) Based on Alternate TRVs (Uncertainty Analysis)
Chromium	American kestrel	Default	Tier 1	*NOAEL* UTL = 2 *LOAEL* UTL = 0.4	Not Calculated
			Tier 2	*NOAEL* UTL = 1 *LOAEL* UTL = 0.2	Not Calculated
		Alternate	Tier 1	Not Calculated	Not Calculated
			Tier 2	Not Calculated	Not Calculated
	Deer Mouse (Insectivore)	Default	Tier 1	**Chromium VI** *NOAEL* UTL = 2 *LOAEL* UTL = 0.4 **Chromium III** *NOAEL* UTL = 0.002	Not Calculated
			Tier 2	**Chromium VI** *NOAEL* UTL = 1 *LOAEL* UTL = 0.2 **Chromium III** *NOAEL* UTL = 0.001	Not Calculated
		Alternate	Tier 1	Not Calculated	Not Calculated
			Tier 2	Not Calculated	Not Calculated
Copper	Mourning Dove (Herbivore)	Default	Tier 1	*NOAEL* UTL = 1 *Threshold* UTL = 0.2 *LOAEL* UTL = 0.05	Not Calculated
			Tier 2	*NOAEL* UTL = 0.8 *Threshold* UTL = 0.2 *LOAEL* UTL = 0.03	Not Calculated
		Alternate (Uncertainty	Tier 1	Not Calculated	Not Calculated
			Tier 2	Not Calculated	Not Calculated

Table 10.1
Hazard Quotient Summary For Non-PMJM Receptors

ECOPC	Receptor	BAF	EPC	Hazard Quotients (HQs) Based on Default TRVs	Hazard Quotients (HQs) Based on Alternate TRVs (Uncertainty Analysis)
Copper	Mourning Dove (Insectivore)	Default	Tier 1	*NOAEL* UTL = 2 *Threshold* UTL = 0.3 *LOAEL* UTL = 0.1	Not Calculated
			Tier 2	*NOAEL* UTL = 1 *Threshold* UTL = 0.3 *LOAEL* UTL = 0.1	Not Calculated
		Alternate	Tier 1	Not Calculated	Not Calculated
			Tier 2	Not Calculated	Not Calculated
Manganese	Terrestrial Plants	N/A	Tier 1	*NOEC* UTL = 1 *LOEC* Not Available	Not Calculated
			Tier 2	*NOEC* UTL = 0.7 *LOEC* Not Available	Not Calculated
	Deer Mouse (Herbivore)	Default	Tier 1	*NOAEL* UTL = 1 *LOAEL* UTL = 0.1	Not Calculated
			Tier 2	*NOAEL* UTL = 0.8 *LOAEL* UTL = 0.1	Not Calculated
		Alternate (Uncertainty	Tier 1	Not Calculated	Not Calculated
			Tier 2	Not Calculated	Not Calculated
Nickel	Mourning Dove (Insectivore)	Default	Tier 1	*NOAEL* UTL = 18 *Threshold* UTL = 3 *LOAEL* UTL = 0.5	Not Calculated
			Tier 2	*NOAEL* UTL = 13 *Threshold* UTL = 2 *LOAEL* UTL = 0.3	Not Calculated

Table 10.1
Hazard Quotient Summary For Non-PMJM Receptors

ECOPC	Receptor	BAF	EPC	Hazard Quotients (HQs) Based on Default TRVs	Hazard Quotients (HQs) Based on Alternate TRVs (Uncertainty Analysis)
Nickel	Mourning Dove (Insectivore)	Alternate (Uncertainty Analysis)	Tier 1 & 2	Not Calculated	Not Calculated
			Tier 2	Not Calculated	Not Calculated
	Deer Mouse (Herbivore)	Default	Tier 1	***NOAEL*** UTL = 1 ***LOAEL*** UTL = 0.1	Not Calculated
			Tier 2	***NOAEL*** UTL = 0.9 ***LOAEL*** UTL = 0.1	Not Calculated
		Alternate	Tier 1	Not Calculated	Not Calculated
			Tier 2	Not Calculated	Not Calculated
	Deer Mouse (Insectivore)	Default	Tier 1	***NOAEL*** UTL = 53 ***LOAEL*** UTL = 5	***NOAEL*** UTL = 0.2 ***LOAEL*** UTL = 0.1
			Tier 2	***NOAEL*** UTL = 36 ***LOAEL*** UTL = 4	***NOAEL*** UTL = 0.1 ***LOAEL*** UTL = 0.1
		Alternate	Tier 1	***NOAEL*** UTL = 12 ***LOAEL*** UTL = 1	***NOAEL*** UTL = 0.04 ***LOAEL*** UTL = 0.02
			Tier 2	***NOAEL*** UTL = 8 ***LOAEL*** UTL = 0.8	***NOAEL*** UTL = 0.03 ***LOAEL*** UTL = 0.01
	Coyote (Generalist)	Default	Tier 1	***NOAEL*** UCL = 3 ***LOAEL*** UCL = 0.3	Not Calculated
			Tier 2	***NOAEL*** UCL = 2 ***LOAEL*** UCL = 0.2	Not Calculated
		Alternate	Tier 1	Not Calculated	Not Calculated
			Tier 2	Not Calculated	Not Calculated

Table 10.1
Hazard Quotient Summary For Non-PMJM Receptors

ECOPC	Receptor	BAF	EPC	Hazard Quotients (HQs) Based on Default TRVs	Hazard Quotients (HQs) Based on Alternate TRVs (Uncertainty Analysis)
Nickel	Coyote (Insectivore)	Default	Tier 1	*NOAEL* UCL = 9 *LOAEL* UCL = 0.9	Not Calculated
Nickel	Coyote (Insectivore)	Default	Tier 2	*NOAEL* UCL = 8 *LOAEL* UCL = 0.8	Not Calculated
Nickel	Coyote (Insectivore)	Alternate	Tier 1	Not Calculated	Not Calculated
Nickel	Coyote (Insectivore)	Alternate	Tier 2	Not Calculated	Not Calculated
Thallium	Terrestrial Plants	N/A	Tier 1	*NOEC* UTL = 2 *LOEC* Not Available	Not Calculated
Thallium	Terrestrial Plants	N/A	Tier 2	*NOEC* UTL = 0.4 *LOEC* Not Available	Not Calculated
Tin	Mourning Dove (Herbivore)	Default	Tier 1	*NOAEL* UTL = 1 *LOAEL* UTL = 0.05	Not Calculated
Tin	Mourning Dove (Herbivore)	Default	Tier 2	*NOAEL* UTL = 0.5 *LOAEL* UTL = 0.02	Not Calculated
Tin	Mourning Dove (Herbivore)	Alternate (Uncertainty Analysis)	Tier 1	Not Calculated	Not Calculated
Tin	Mourning Dove (Herbivore)	Alternate (Uncertainty Analysis)	Tier 2	Not Calculated	Not Calculated
Tin	Mourning Dove (Insectivore)	Default	Tier 1	*NOAEL* UTL = 10 *LOAEL* UTL = 0.4	Not Calculated
Tin	Mourning Dove (Insectivore)	Default	Tier 2	*NOAEL* UTL = 4 *LOAEL* UTL = 0.2	Not Calculated
Tin	Mourning Dove (Insectivore)	Alternate (Uncertainty	Tier 1	Not Calculated	Not Calculated
Tin	Mourning Dove (Insectivore)	Alternate (Uncertainty	Tier 2	Not Calculated	Not Calculated
Tin	American kestrel	Default	Tier 1	*NOAEL* UTL = 2 *LOAEL* UTL = 0.1	Not Calculated

Table 10.1
Hazard Quotient Summary For Non-PMJM Receptors

ECOPC	Receptor	BAE	EPC	Hazard Quotients (HQs)	
				Based on Default TRVs	Based on Alternate TRVs (Uncertainty Analysis)
Tin	American kestrel	Default	Tier 2	*NOAEL* UTL = 0.7 *LOAEL* UTL = 0.03	Not Calculated
		Alternate	Tier 1	Not Calculated	Not Calculated
			Tier 2	Not Calculated	Not Calculated
	Deer Mouse (Insectivore)	Default	Tier 1	*NOAEL* UTL = 8 *LOAEL* UTL = 0.1	Not Calculated
			Tier 2	*NOAEL* UTL = 3 *LOAEL* UTL = 0.1	Not Calculated
		Alternate	Tier 1	Not Calculated	Not Calculated
			Tier 2	Not Calculated	Not Calculated
Vanadium	Terrestrial Plants	N/A	Tier 1	*NOEC* UTL = 29 *LOEC* Not Available	Not Calculated
			Tier 2	*NOEC* UTL = 20 *LOEC* Not Available	Not Calculated
	Deer Mouse (Insectivore)	Default	Tier 1	*NOAEL* UTL = 2 *LOAEL* UTL = 0.2	Not Calculated
			Tier 2	*NOAEL* UTL = 1 *LOAEL* UTL = 0.1	Not Calculated
		Alternate	Tier 1	Not Calculated	Not Calculated
			Tier 2	Not Calculated	Not Calculated

Shaded cells represent default HQ calculations based on exposure and toxicity models specifically identified in the CRA Methodology.
All HQ Calculations are provided in Attachment 4.
Discussion of the chemical-specific uncertainties are provided in Attachment 5.

Table 10.2
Hazard Quotient Summary For PMJM Receptors

ECOPC	Patch	BAF	EPC	Hazard Quotients (HQs)	
				Based on Default TRVs	Based on Alternate TRVs (Uncertainty Analyisis)
Chromium	Patch 22	Default	UCL[a]	***Chromium VI*** ***NOAEL = 1*** ***LOAEL = 0.3*** ***Chromium III*** ***NOAEL = 0.001***	Not Calculated
		Alternate (Uncertainty Analysis)	UCL	Not Calculated	Not Calculated
	Patch 23	Default	UCL	***Chromium VI*** ***NOAEL = 1*** ***LOAEL = 0.3*** ***Chromium III*** ***NOAEL = 0.001***	Not Calculated
		Alternate	UCL	Not Calculated	Not Calculated
Copper	Patch 23	Default	UCL	***NOAEL = 6*** ***LOAEL = 0.007***	Not Calculated
		Alternate	UCL	Not Calculated	Not Calculated
Manganese	Patch 22	Default	UCL[a]	***NOAEL = 2*** ***LOAEL = 0.1***	Not Calculated
		Alternate	UCL	Not Calculated	Not Calculated
	Patch 23	Default	UCL	***NOAEL = 2*** ***LOAEL = 0.1***	Not Calculated
		Alternate	UCL	Not Calculated	Not Calculated
	Patch 27	Default	UCL[a]	***NOAEL = 2*** ***LOAEL = 0.2***	Not Calculated
		Alternate	UCL	Not Calculated	Not Calculated
Nickel	Patch 22	Default	UCL[a]	***NOAEL = 36*** ***LOAEL = 4***	NOAEL = 0.1 LOAEL = 0.1
		Alternate	UCL	NOAEL = 9 LOAEL = 0.9	NOAEL = 0.03 LOAEL = 0.02
	Patch 23	Default	UCL	***NOAEL = 34*** ***LOAEL = 3***	NOAEL = 0.1 LOAEL = 0.1
		Alternate	UCL	NOAEL = 9 LOAEL = 0.9	NOAEL = 0.03 LOAEL = 0.01
	Patch 24	Default	UCL[a]	***NOAEL = 28*** ***LOAEL = 3***	NOAEL = 0.1 LOAEL = 0.1
		Alternate	UCL	NOAEL = 7 LOAEL = 0.7	NOAEL = 0.02 LOAEL = 0.01
	Patch 27	Default	UCL[a]	***NOAEL = 85*** ***LOAEL = 9***	NOAEL = 0.3 LOAEL = 0.1
		Alternate	UCL	NOAEL = 21 LOAEL = 2	NOAEL = 0.1 LOAEL = 0.04

92

Table 10.2
Hazard Quotient Summary For PMJM Receptors

ECOPC	Patch	BAF	EPC	Hazard Quotients (HQs)	
				Based on Default TRVs	Based on Alternate TRVs (Uncertainty Analyisis)
Selenium	Patch 23	Default	UCL	*NOAEL = 1* *LOAEL = 0.1*	Not Calculated
		Alternate	UCL	Not Calculated	Not Calculated
Tin	Patch 23	Default	UCL	*NOAEL = 0.8* *LOAEL = 0.01*	Not Calculated
		Alternate (Uncertainty Analysis)	UCL	Not Calculated	Not Calculated
	Patch 25	Default	UCL[a]	*NOAEL = 6* *LOAEL = 0.1*	Not Calculated
		Alternate	UCL	Not Calculated	Not Calculated
Vanadium	Patch 22	Default	UCL[a]	*NOAEL = 2* *LOAEL = 0.02*	Not Calculated
		Alternate (Uncertainty Analysis)	UCL	Not Calculated	Not Calculated
	Patch 23	Default	UCL	*NOAEL = 2* *LOAEL = 0.2*	Not Calculated
		Alternate	UCL	Not Calculated	Not Calculated
Zinc	Patch 23	Default	UCL	*NOAEL = 2* *LOAEL = 0.1*	Not Calculated
		Alternate (Uncertainty Analysis)	UCL	Not Calculated	Not Calculated
	Patch 27	Default	UCL[a]	*NOAEL = 3* *LOAEL = 0.1*	Not Calculated
		Alternate	UCL	Not Calculated	Not Calculated

[a]Not enough samples were available to calculate a UCL. The MDC was used as a default.
Shaded cells represent default HQ calculations based on exposure and toxicity models specifically identified in the CRA Methodology.
All HQ Calculations are provided in Attachment 4.
Discussion of the chemical-specific uncertainties are provided in Attachment 5.

Table 10.3
Tier 2 Grid Cell Hazard Quotients for Surface Soil in LWOEU

ECOPC	Most Sensitive Receptor	Number of Grid Cells	Percent of Tier 2 Grid Means											
			NOAEL TRV				Threshold TRV				LOAEL TRV			
			HQ < 1	HQ ≥ 1 <5	HQ ≥ 5 <10	HQ ≥ 10	HQ < 1	HQ ≥ 1 <5	HQ ≥ 5 <10	HQ ≥ 10	HQ < 1	HQ ≥ 1 <5	HQ ≥ 5 <10	HQ ≥ 10
Inorganics														
Chromium	Mourning Dove - Insectivore	26	0	0	46	54	N/A	N/A	N/A	N/A	0	100	0	0
Copper	Mourning Dove - Insectivore	26	0	100	0	0	100	0	0	0	100	0	0	0
Manganese	Mourning Dove - Herbivore	26	92	8	0	0	N/A	N/A	N/A	N/A	100	0	0	0
Nickel	Deer Mouse - Insectivore	26	0	0	0	100	N/A	N/A	N/A	N/A	0	92	8	0
Tin	Mourning Dove - Insectivore	23	35	43	9	13	N/A	N/A	N/A	N/A	100	0	0	0
Vanadium	Deer Mouse - Insectivore	26	38	62	0	0	N/A	N/A	N/A	N/A	100	0	0	0

N/A = No value available.
The limiting receptor is chosen as the receptor with the lowest ESL.
Default exposure and toxicity parameters used.

Table 11.1
Summary of Risk Characterization Results for the LWOEU

Analyte	Ecological Receptors	Result of Risk Characterization	Lines of Evidence Risk Conclusions
Surface Soil Non-PMJM Receptors			
Chromium	Terrestrial plants	Screening ESL HQs>1 for all EPCs. Alternate NOEC HQs >1 for all EPCs Alternate LOEC HQs <1 for all EPCs.	Low Risk
	Terrestrial invertebrate	Screening ESL HQs>1 for all EPCs. Alternate LOEC HQs <1 for all EPCs	Low Risk
	American kestrel	NOAEL HQs >= 1 for default exposures and TRVs. LOAEL HQs <1 for default exposures and TRVs.	Low Risk
	Mourning dove (herbivore)	NOAEL HQs <= 1 for default exposures and TRVs. LOAEL HQs <1 for default exposures and TRVs.	Low Risk
	Mourning dove (insectivore)	NOAEL HQs > 1 for default exposures and TRVs. LOAEL HQs >1 for default exposures and TRVs. NOAEL HQs >=1 for alternative exposures using default TRVs. LOAEL HQs <1 for alternative exposures and default TRVs.	Low Risk
	Deer mouse (herbivore)	Not an ECOPC.	Not an ECOPC
	Deer mouse (Insectivore)	NOAEL HQs >= 1 for default exposures and Cr VI TRV. NOAEL HQs <1 for default exposures and Cr III TRV. LOAEL HQs <1 for default exposures and Cr VI TRV.	Low Risk
	Prairie dog	Not an ECOPC.	Not an ECOPC
	Coyote (carnivore)	Not an ECOPC.	Not an ECOPC
	Coyote (generalist)	Not an ECOPC.	Not an ECOPC
	Coyote (insectivore)	Not an ECOPC.	Not an ECOPC
	Mule Deer	Not an ECOPC.	Not an ECOPC
Copper	Terrestrial plants	Not an ECOPC.	Not an ECOPC
	Terrestrial invertebrate	Not an ECOPC.	Not an ECOPC
	American kestrel	Not an ECOPC.	Not an ECOPC
	Mourning dove (herbivore)	NOAEL HQs <= 1 for default exposures. Threshold HQs <1 for all default exposures LOAEL HQs <1 for all default exposure.	Low Risk
	Mourning dove (insectivore)	NOAEL HQs >= 1 for default exposure scenarios. Threshold HQs <1 for all default exposure scenarios. LOAEL HQs <1 for all default exposure scenarios.	Low Risk
	Deer mouse (herbivore)	Not an ECOPC.	Low Risk
	Deer mouse (Insectivore)	Not an ECOPC.	Low Risk
	Prairie dog	Not an ECOPC.	Low Risk
	Coyote (carnivore)	Not an ECOPC.	Low Risk
	Coyote (generalist)	Not an ECOPC.	Low Risk
	Coyote (insectivore)	Not an ECOPC.	Low Risk
	Mule Deer	Not an ECOPC.	Low Risk
Manganese	Terrestrial plants	Screening ESL HQs =1 for Tier 1 UTL EPC. Screening ESL HQs <1 for Tier 1 Tier 2 UTL EPC.	Low Risk
	Terrestrial invertebrate	Not an ECOPC.	ECOPC of Uncertain Risk
	American kestrel	Not an ECOPC.	Not an ECOPC
	Mourning dove (herbivore)	Not an ECOPC.	Not an ECOPC
	Mourning dove (insectivore)	Not an ECOPC.	Not an ECOPC
	Deer mouse (herbivore)	NOAEL HQs <= 1 for default exposures. LOAEL HQs <1 for all default exposures.	Low Risk
	Deer mouse (Insectivore)	Not an ECOPC.	Not an ECOPC
	Prairie dog	Not an ECOPC.	Not an ECOPC
	Coyote (carnivore)	Not an ECOPC.	Not an ECOPC
	Coyote (generalist)	Not an ECOPC.	Not an ECOPC
	Coyote (insectivore)	Not an ECOPC.	Not an ECOPC
	Mule Deer	Not an ECOPC.	Not an ECOPC

Table 11.1
Summary of Risk Characterization Results for the LWOEU

Analyte	Ecological Receptors	Result of Risk Characterization	Lines of Evidence Risk Conclusions
Nickel	Terrestrial plants	Not an ECOPC.	Not an ECOPC
	Terrestrial invertebrate	Not an ECOPC.	Not an ECOPC
	American kestrel	Not an ECOPC.	Not an ECOPC
	Mourning dove (herbivore)	Not an ECOPC.	Not an ECOPC
	Mourning dove (insectivore)	NOAEL HQs > 1 for default exposures and TRVs. Threshold HQs >1 for default exposures and TRVs. LOAEL HQs <1 for default exposures and TRVs.	Low Risk
	Deer mouse (herbivore)	NOAEL HQs <= 1 for default exposures and TRVs. LOAEL HQs <1 for default exposures and TRVs.	Low Risk
	Deer mouse (insectivore)	NOAEL HQs > 1 for default exposures and TRVs. LOAEL HQs >1 for default exposures and TRVs. NOAEL HQs < 1 for default exposures and alternative TRVs. LOAEL HQs <1 for default exposures and alternative TRVs. NOAEL HQs > 1 for alternative exposures and default TRVs. LOAEL HQs <=1 for alternative exposures and default TRVs. NOAEL HQs < 1 for alternative exposures and alternative TRVs. LOAEL HQs <1 for alternative exposures and alternative TRVs.	Low Risk
	Prairie dog	Not an ECOPC.	Not an ECOPC
	Coyote (carnivore)	Not an ECOPC.	Not an ECOPC
	Coyote (generalist)	NOAEL HQs >1 for default exposures and TRVs. LOAEL HQs <1 for default exposures and TRVs.	Low Risk
	Coyote (insectivore)	NOAEL HQs >1 for default exposures and TRVs. LOAEL HQs <=1 for default exposures and TRVs.	Low Risk
	Mule Deer	Not an ECOPC.	Not an ECOPC
Thallium	Terrestrial plants	Screening ESL HQs >1 for Tier 1 EPCs. Screening ESL HQs <1 for Tier 2 EPCs.	Low Risk
	Terrestrial invertebrate	Not an ECOPC.	ECOPC of Uncertain Risk
	American kestrel	Not an ECOPC.	Not an ECOPC
	Mourning dove (herbivore)	Not an ECOPC.	Not an ECOPC
	Mourning dove (insectivore)	Not an ECOPC.	Not an ECOPC
	Deer mouse (herbivore)	Not an ECOPC.	Not an ECOPC
	Deer mouse (Insectivore)	Not an ECOPC.	Not an ECOPC
	Prairie dog	Not an ECOPC.	Not an ECOPC
	Coyote (carnivore)	Not an ECOPC.	Not an ECOPC
	Coyote (generalist)	Not an ECOPC.	Not an ECOPC
	Coyote (insectivore)	Not an ECOPC.	Not an ECOPC
	Mule Deer	Not an ECOPC.	Not an ECOPC
Tin	Terrestrial plants	Not an ECOPC.	Not an ECOPC
	Terrestrial invertebrate	Not an ECOPC.	ECOPC of Uncertain Risk
	American kestrel	NOAEL HQs > 1 for Tier 1 UTL < 1for Tier 2 UTL. LOAEL HQs <1 for default exposures and TRVs.	Low Risk
	Mourning dove (herbivore)	NOAEL HQs > 1 for Tier 1 UTL < 1for Tier 2 UTL. LOAEL HQs <1 for default exposures and TRVs.	Low Risk
	Mourning dove (insectivore)	NOAEL HQs >1 for default exposures. LOAEL HQs <1 for default exposures and TRVs.	Low Risk
	Deer mouse (herbivore)	Not an ECOPC.	Not an ECOPC
	Deer mouse (Insectivore)	NOAEL HQs >1 for default exposures. LOAEL HQs <1 for default exposures and TRVs.	Low Risk
	Prairie dog	Not an ECOPC.	Not an ECOPC
	Coyote (carnivore)	Not an ECOPC.	Not an ECOPC
	Coyote (generalist)	Not an ECOPC.	Not an ECOPC
	Coyote (insectivore)	Not an ECOPC.	Not an ECOPC
	Mule Deer	Not an ECOPC.	Not an ECOPC

Table 11.1
Summary of Risk Characterization Results for the LWOEU

Analyte	Ecological Receptors	Result of Risk Characterization	Lines of Evidence Risk Conclusions
Vanadium	Terrestrial plants	Screening ESL HQs >1 for all EPCs.	Low Risk
	Terrestrial invertebrate	Not an ECOPC.	ECOPC of Uncertain Risk
	American kestrel	Not an ECOPC.	Not an ECOPC
	Mourning dove (herbivore)	Not an ECOPC.	Not an ECOPC
	Mourning dove (insectivore)	Not an ECOPC.	Not an ECOPC
	Deer mouse (herbivore)	Not an ECOPC.	Not an ECOPC
	Deer mouse (Insectivore)	NOAEL HQs >= 1 for default exposures. LOAEL HQs <1 for all default exposures.	Low Risk
	Prairie dog	Not an ECOPC.	Not an ECOPC
	Coyote (carnivore)	Not an ECOPC.	Not an ECOPC
	Coyote (generalist)	Not an ECOPC.	Not an ECOPC
	Coyote (insectivore)	Not an ECOPC.	Not an ECOPC
	Mule Deer	Not an ECOPC.	Not an ECOPC
Surface Soil - PMJM Receptors			
Chromium	PMJM - Patch 22	NOAEL HQs = 1 for default exposures and Cr VI TRVs LOAEL HQs <1 for default exposures and Cr VI TRVs. NOAEL HQs <1 for default exposures and Cr III TRVs.	Low Risk
	PMJM - Patch 23	NOAEL HQs = 1 for default exposures and Cr VI TRVs LOAEL HQs <1 for default exposures and Cr VI TRVs. NOAEL HQs <1 for default exposures and Cr III TRVs.	Low Risk
	PMJM - Patch 24	Not an ECOPC.	Not an ECOPC
	PMJM - Patch 25	Not an ECOPC.	Not an ECOPC
	PMJM - Patch 26	Not an ECOPC.	Not an ECOPC
	PMJM - Patch 27	Not an ECOPC.	Not an ECOPC
	PMJM - Patch 28	Not an ECOPC.	Not an ECOPC
Manganese	PMJM - Patch 22	NOAEL HQs > 1 for default exposures. LOAEL HQs <1 for all default exposures.	Low Risk
	PMJM - Patch 23	NOAEL HQs >1 for default exposures LOAEL HQs <1 for all default exposures.	Low Risk
	PMJM - Patch 24	Not an ECOPC.	Not an ECOPC
	PMJM - Patch 25	Not an ECOPC.	Not an ECOPC
	PMJM - Patch 26	Not an ECOPC.	Not an ECOPC
	PMJM - Patch 27	NOAEL HQs >1 for default exposures LOAEL HQs <1 for all default exposures.	Low Risk
	PMJM - Patch 28	Not an ECOPC.	Not an ECOPC
Nickel	PMJM - Patch 22	NOAEL HQs >1 for default exposures and TRVs. LOAEL HQs >1 for all default exposures and TRVs. NOAEL HQs >1 for all alternative exposures and default TRVs. LOAEL HQs <1 for all alternative exposures and default TRVs. NOAEL LOAEL HQs <1 for all default and alternative exposures using alternative TRVs.	Low to Moderate Risk
	PMJM - Patch 23	NOAEL HQs >1 for default exposures and TRVs. LOAEL HQs >1 for all default exposures and TRVs. NOAEL HQs >1 for all alternative exposures and default TRVs. LOAEL HQs <1 for all alternative exposures and default TRVs. NOAEL LOAEL HQs <1 for all default and alternative exposures using alternative TRVs.	Low to Moderate Risk
	PMJM - Patch 24	NOAEL HQs >1 for default exposures and TRVs. LOAEL HQs >1 for all default exposures and TRVs. NOAEL HQs >1 for all alternative exposures and default TRVs. LOAEL HQs <1 for all alternative exposures and default TRVs. NOAEL LOAEL HQs <1 for all default and alternative exposures using alternative TRVs.	Low to Moderate Risk
	PMJM - Patch 25	Not an ECOPC.	Not an ECOPC
	PMJM - Patch 26	Not an ECOPC.	Not an ECOPC
	PMJM - Patch 27	NOAEL HQs >1 for default exposures and TRVs. LOAEL HQs >1 for all default exposures and TRVs. NOAEL HQs >1 for all alternative exposures and default TRVs. LOAEL HQs <1 for all alternative exposures and default TRVs. NOAEL LOAEL HQs <1 for all default and alternative exposures using alternative TRVs.	Low to Moderate Risk
	PMJM - Patch 28	Not an ECOPC.	Not an ECOPC

97

Table 11.1
Summary of Risk Characterization Results for the LWOEU

Analyte	Ecological Receptors	Result of Risk Characterization	Lines of Evidence Risk Conclusions[a]
Selenium	PMJM - Patch 22	Not an ECOPC.	Not an ECOPC
	PMJM - Patch 23	NOAEL HQ =1 using default exposures. LOAEL HQ <1 using default exposures.	Low Risk
	PMJM - Patch 24	Not an ECOPC.	Not an ECOPC
	PMJM - Patch 25	Not an ECOPC.	Not an ECOPC
	PMJM - Patch 26	Not an ECOPC.	Not an ECOPC
	PMJM - Patch 27	Not an ECOPC.	Not an ECOPC
	PMJM - Patch 28	Not an ECOPC.	Not an ECOPC
Tin	PMJM - Patch 22	Not an ECOPC.	Not an ECOPC
	PMJM - Patch 23	NOAEL HQs < 1 using default exposures. LOAEL HQs <1 using default exposures.	Low Risk
	PMJM - Patch 24	Not an ECOPC.	Not an ECOPC
	PMJM - Patch 25	NOAEL HQ >1 using default exposures. LOAEL HQs <1 for all default exposures and TRVs.	Low Risk
	PMJM - Patch 26	Not an ECOPC.	Not an ECOPC
	PMJM - Patch 27	Not an ECOPC.	Not an ECOPC
	PMJM - Patch 28	Not an ECOPC.	Not an ECOPC
Vanadium	PMJM - Patch 22	NOAEL HQs >1 for default exposures LOAEL HQs <1 for default exposures	Low Risk
	PMJM - Patch 23	NOAEL HQs >1 for default exposures LOAEL HQs <1 for default exposures	Low Risk
	PMJM - Patch 24	Not an ECOPC.	Not an ECOPC
	PMJM - Patch 25	Not an ECOPC.	Not an ECOPC
	PMJM - Patch 26	Not an ECOPC.	Not an ECOPC
	PMJM - Patch 27	Not an ECOPC.	Not an ECOPC
	PMJM - Patch 28	Not an ECOPC.	Not an ECOPC
Zinc	PMJM - Patch 22	Not an ECOPC.	Not an ECOPC
	PMJM - Patch 23	NOAEL HQs >1 for default exposures LOAEL HQs <1 for all default exposures and TRVs.	Low Risk
	PMJM - Patch 24	Not an ECOPC.	Not an ECOPC
	PMJM - Patch 25	Not an ECOPC.	Not an ECOPC
	PMJM - Patch 26	Not an ECOPC.	Not an ECOPC
	PMJM - Patch 27	NOAEL HQs >1 for default exposures LOAEL HQs <1 for all default exposures and TRVs.	Low Risk
	PMJM - Patch 28	Not an ECOPC.	Not an ECOPC
Subsurface Soil			
None	Prairie dog	No ECOPCs.	No Risk

[a] Risk conclusions discussed in detail for each ECOPC in Section 10.

98

FIGURES

100

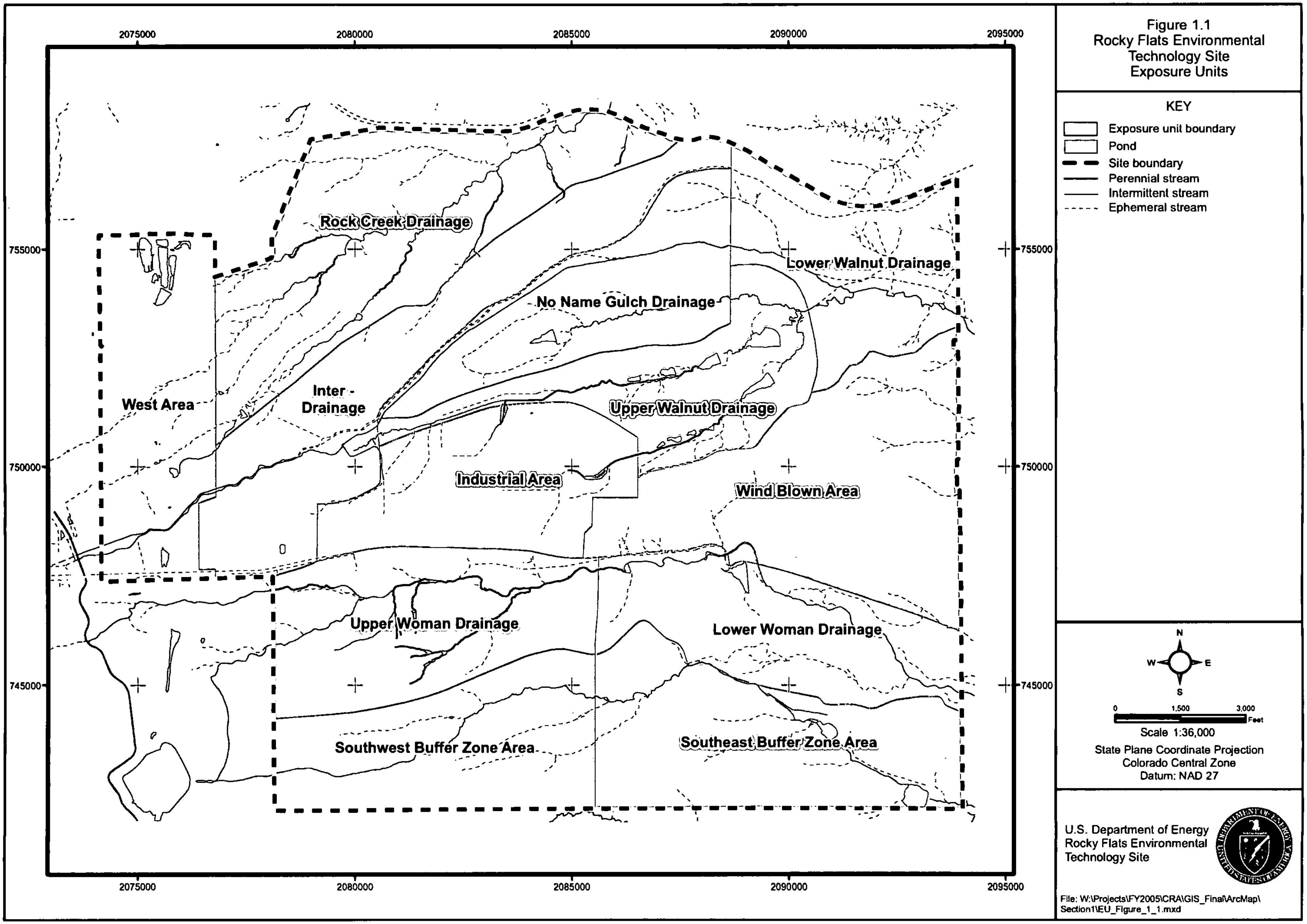


Figure 1.1
Rocky Flats Environmental Technology Site
Exposure Units

101

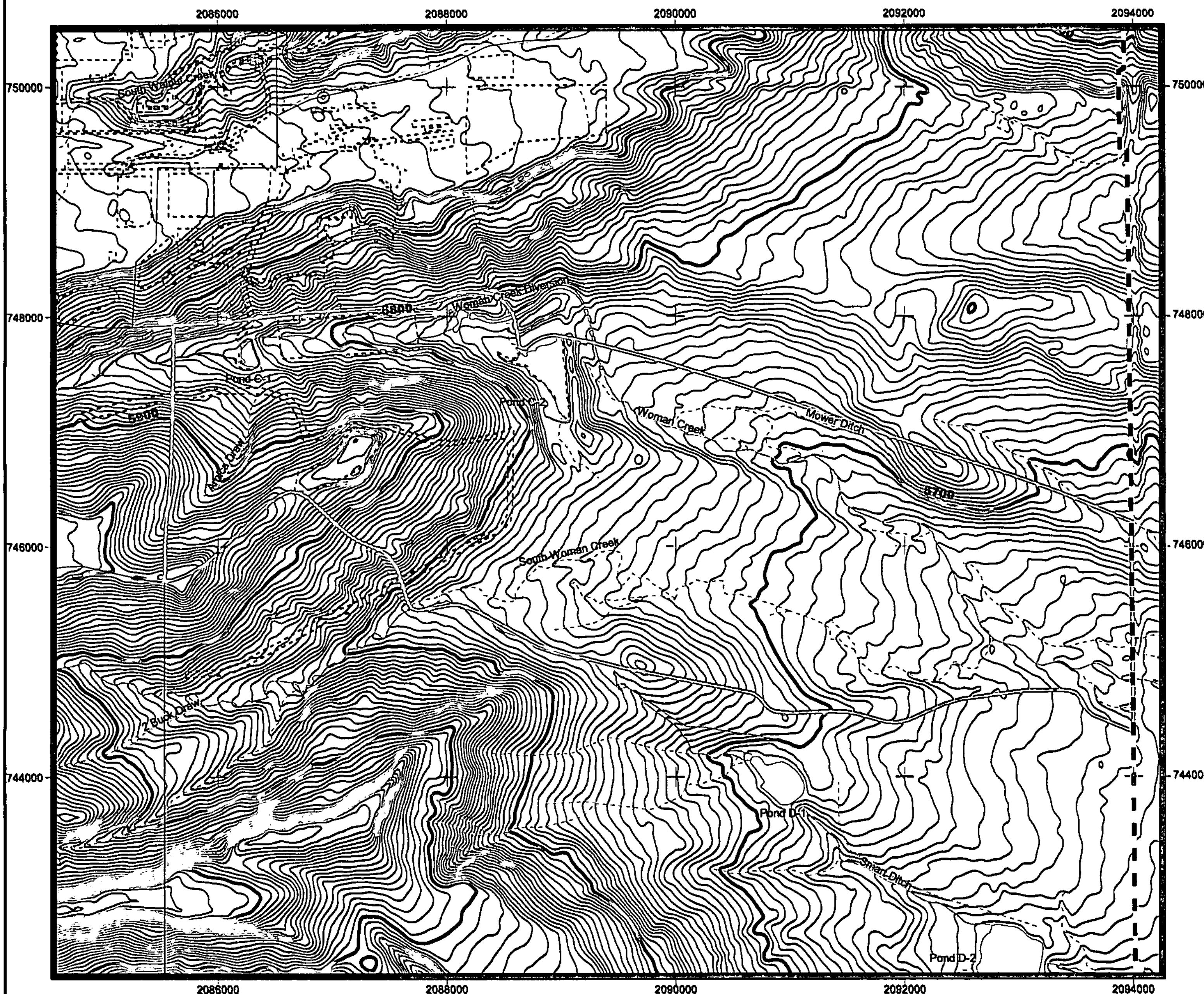


Figure 1.2
Topography and Historical IHSS Locations in the Lower Woman Drainage Exposure Unit

KEY

- Lower Woman Drainage EU
- Historical IHSS/PAC
- Topographic contour interval = 5 ft.

Standard Map Features

- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N
W
E
S

0 650 1300 Feet

Scale 1:15600

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

File: W:\Projects\Fy2005\CRA\GIS_Final\ArcView\Section1\LowerWoman.apr

102

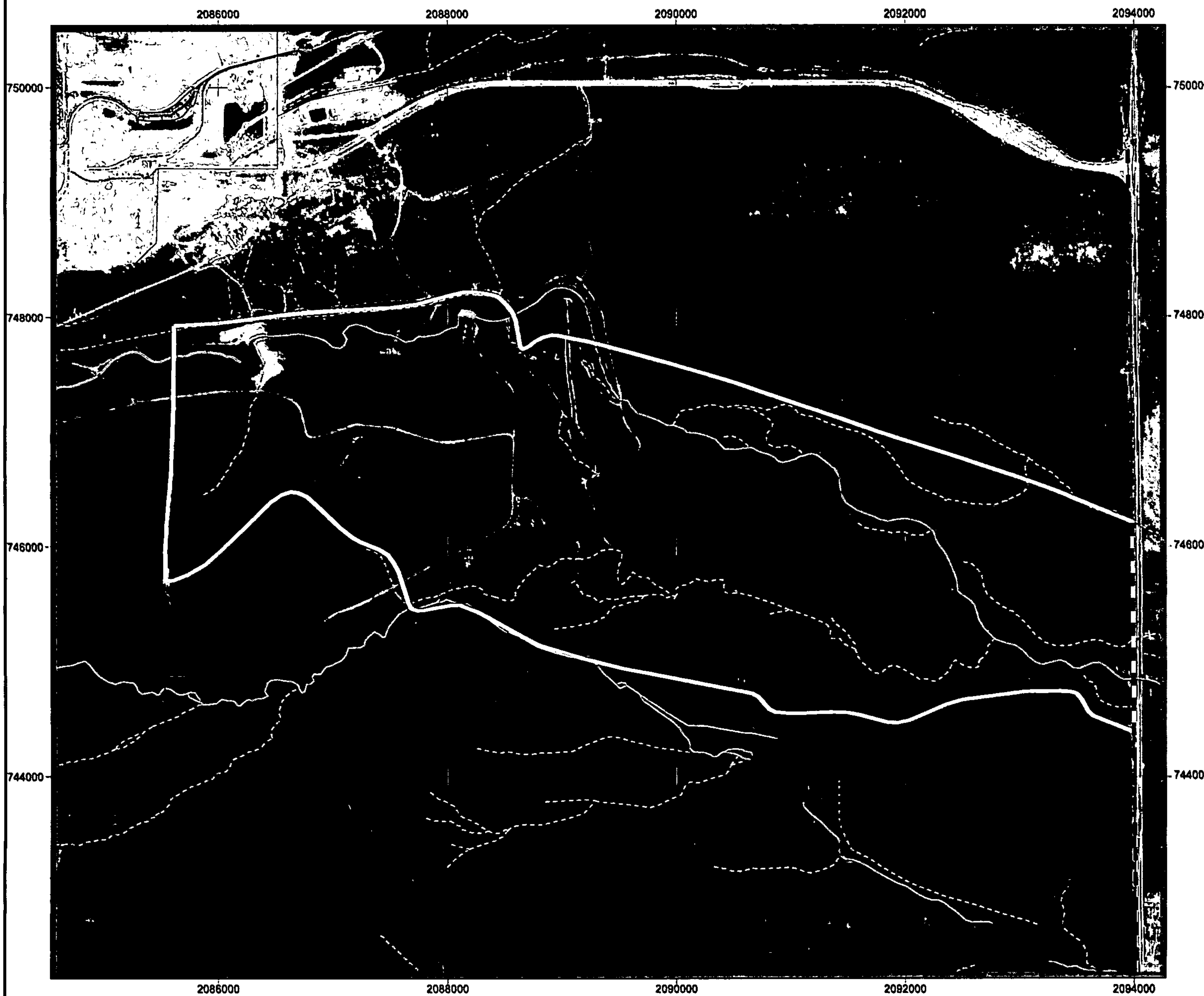


Figure 1.3
Aerial Photograph of the
Lower Woman Drainage
Exposure Unit
July 2005

KEY

Lower Woman Drainage EU

Standard Map Features

Exposure unit boundary
Pond
Site boundary
Perennial stream
Intermittent stream
Ephemeral stream

N W E S

0 650 1300 Feet

Scale 1:15600

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental
Technology Site

File: W:\Projects\Fy2005\CRA\GIS_Final\ArcView\Section1\LowerWoman.apr

103

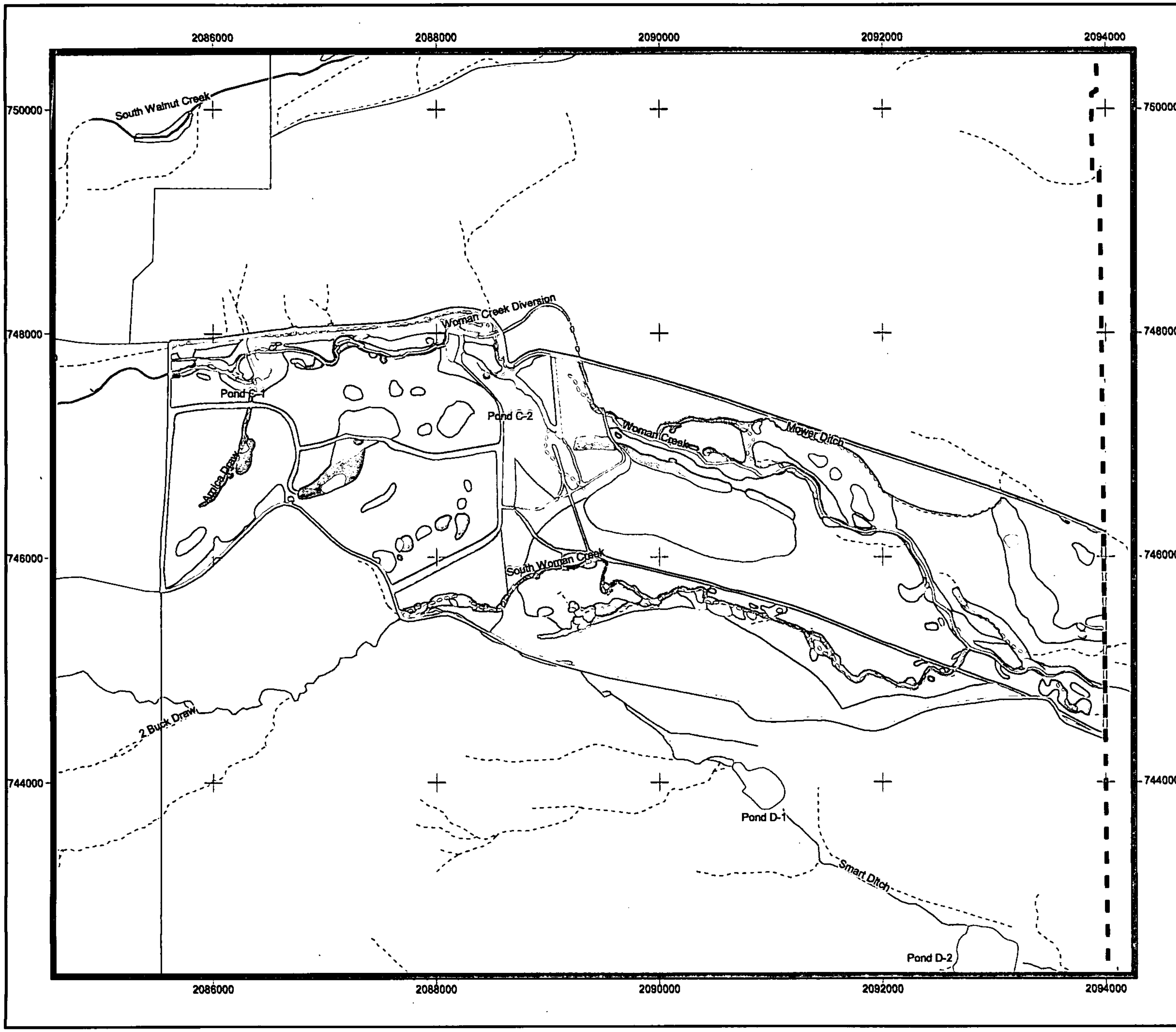


Figure 1.4
Vegetation in the Lower Woman Drainage Exposure Unit

KEY

Lower Woman Drainage EU

Vegetation, 1996
- Annual grass/forb community
- Disturbed and developed areas
- Leadplant riparian shrubland
- Mesic mixed grassland
- Mudflats
- Open water
- Ponderosa woodland
- Reclaimed mixed grassland
- Riparian woodland
- Riprap, rock, and gravel piles
- Savannah shrubland
- Short grassland
- Short marsh
- Short upland shrubland
- Tall marsh
- Tall upland shrubland
- Tree plantings
- Wet meadow/marsh ecotone
- Willow riparian shrubland
- Xeric needle and thread grass prairie
- Xeric tallgrass prairie

Standard Map Features
- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N
W
E
S

0 650 1300 Feet

Scale 1:15600

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

File: W:\Projects\Fy2005\CRA\GIS_Final\ArcView\Section1\LowerWoman.apr

104

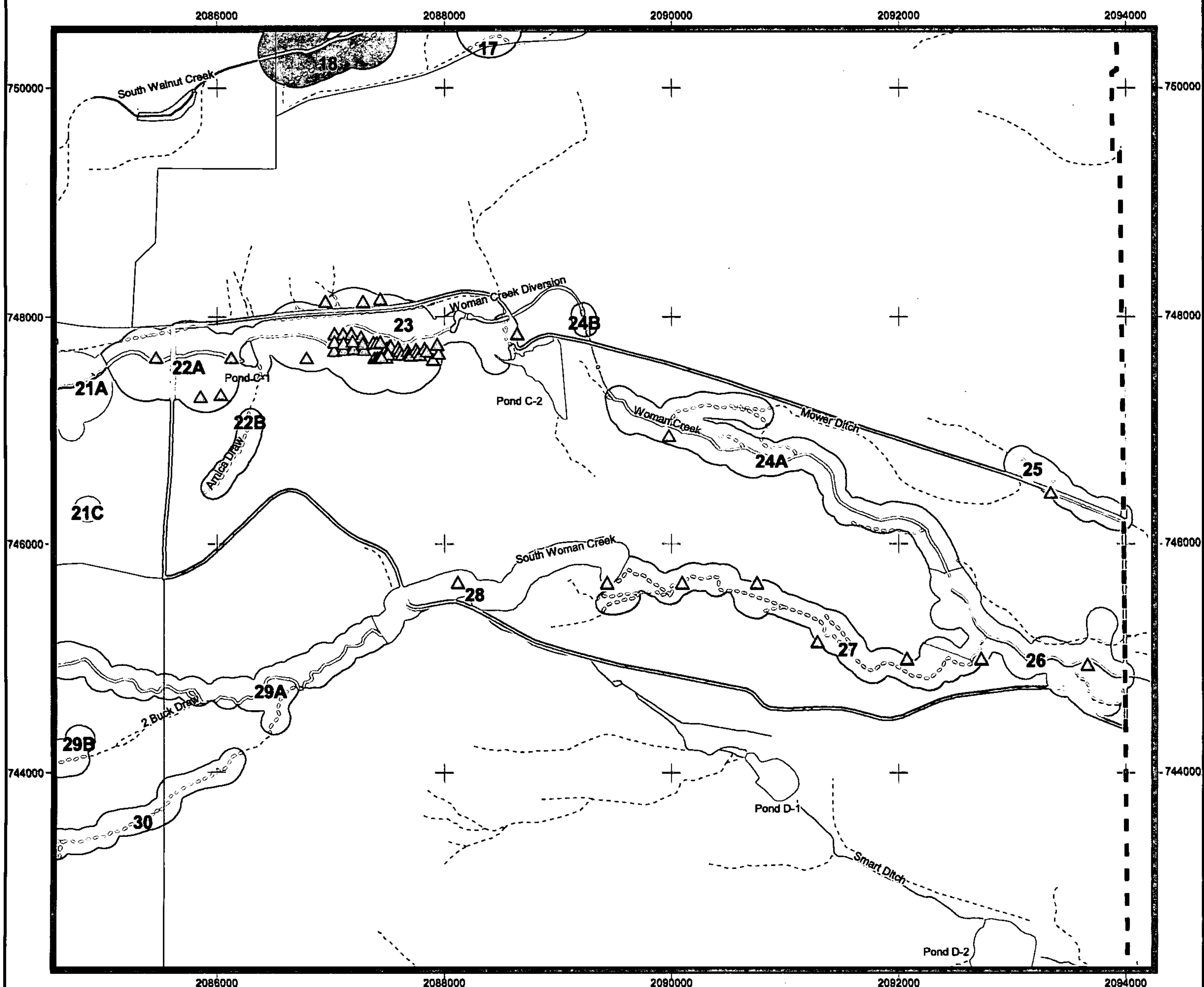


Figure 1.5
Preble's Meadow Jumping Mouse Habitat and Surface Soil Sample Locations in the Lower Woman Drainage Exposure Unit

KEY

- Surface soil sample location
- Lower Woman Drainage EU
- PMJM habitat patch
- 1 PMJM habitat patch ID

Note: Not all analyte groups were analyzed at every sample location.

Standard Map Features

- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N E S W

0 650 1300 Feet

Scale 1:15600

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

File: W:\Projects\Fy2005\CRA\GIS_Final\ArcView\Section1\LowerWoman.apr

18

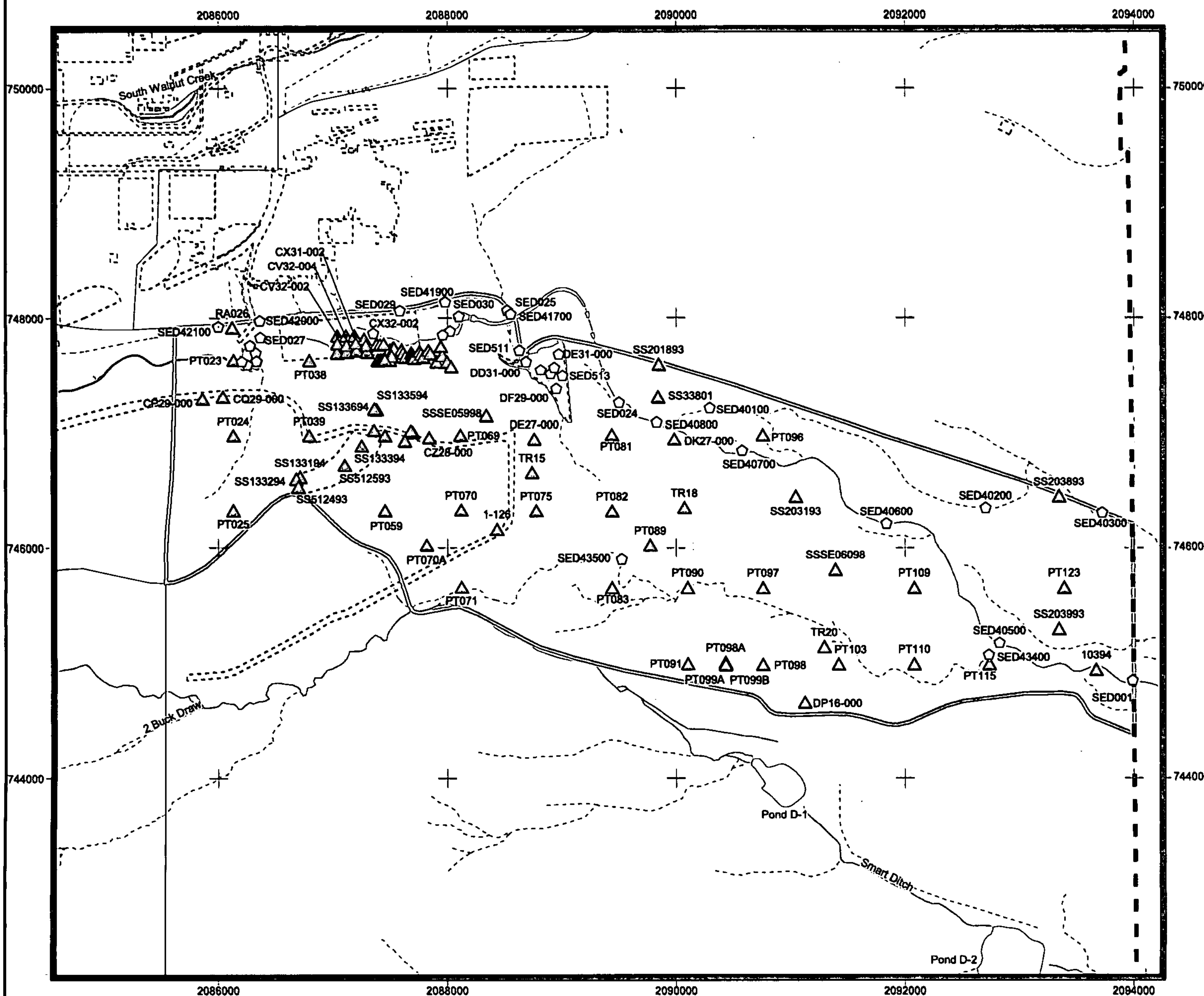


Figure 1.6
Lower Woman Drainage Exposure Unit Surface Soil and Surface Sediment Sample Locations

KEY

Sample location
- Surface sediment sample location
- Surface soil sample location

(Background locations shown in red)
- Surface sediment sample location
- Surface soil sample location
- Lower Woman Drainage EU
- Historical IHSS/PAC

Standard Map Features
- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N
W E
S

0 650 1300 Feet

Scale 1:15600

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

File: W:\Projects\Fy2005\CRA\GIS_Final\ArcView\Section1\LowerWoman.apr

106

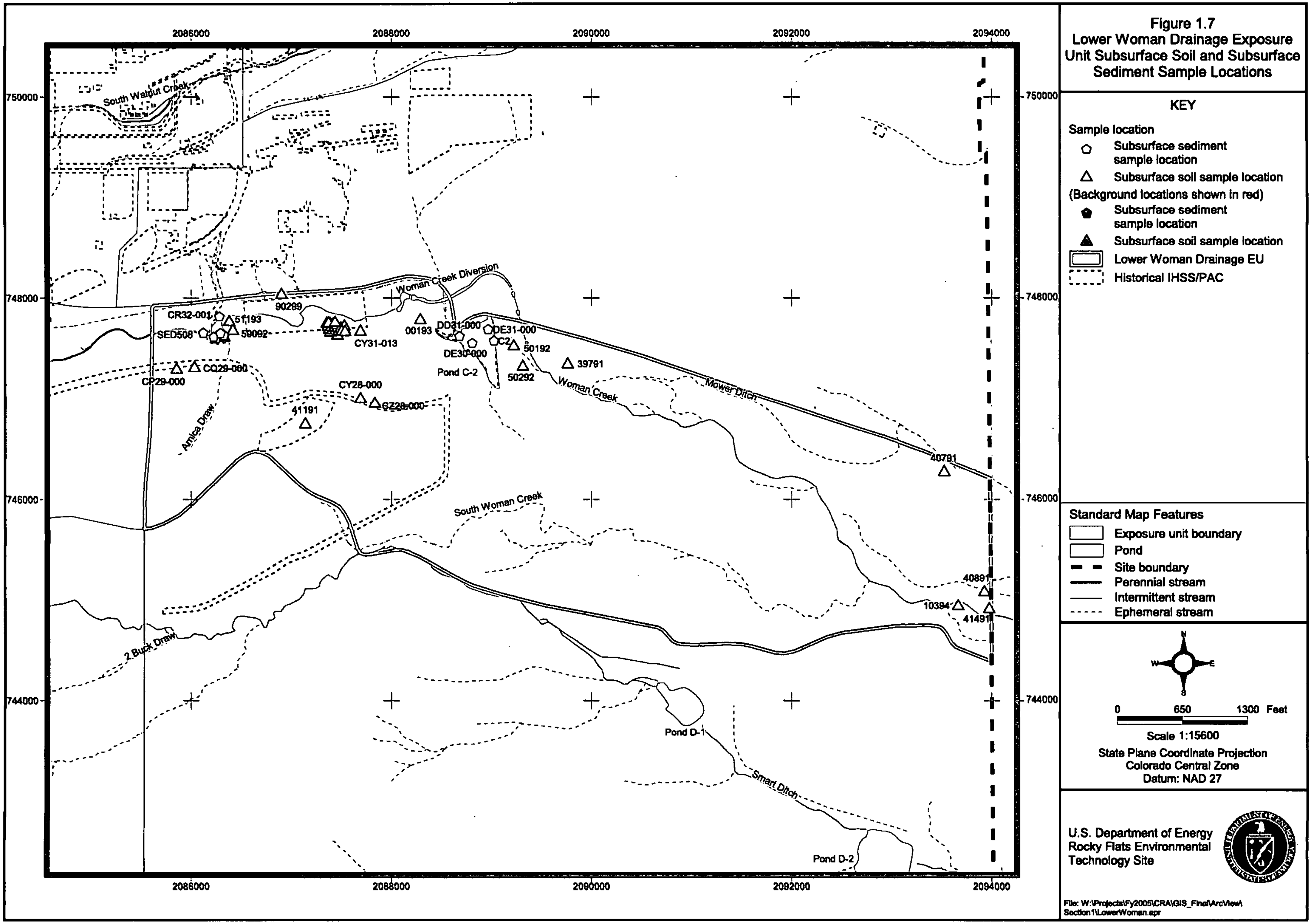


Figure 1.7
Lower Woman Drainage Exposure Unit Subsurface Soil and Subsurface Sediment Sample Locations

107

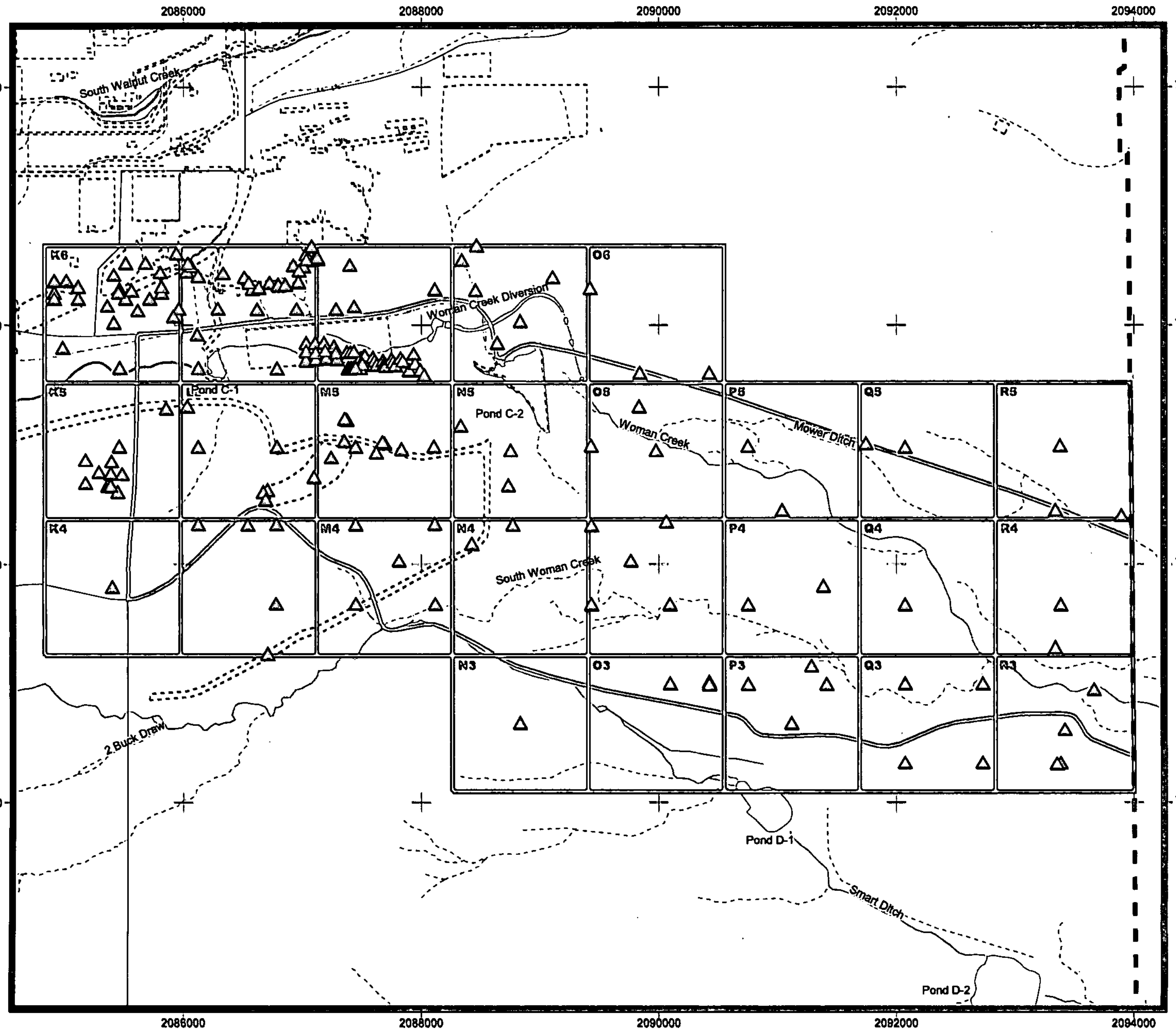


Figure 8.1
Tier 2 EPC 30-acre Grids with Surface Soil Sample Locations

KEY

- Surface soil sample location
- Lower Woman Drainage EU
- 30-acre grid
- Historical IHSS/PAC
- A1 Grid cell ID

Standard Map Features

- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N W E S

0 650 1300 Feet

Scale 1:15600

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

File: W:\Projects\Fy2005\CRA\GIS_Final\ArcView\Section8\LowerWoman.apr

108

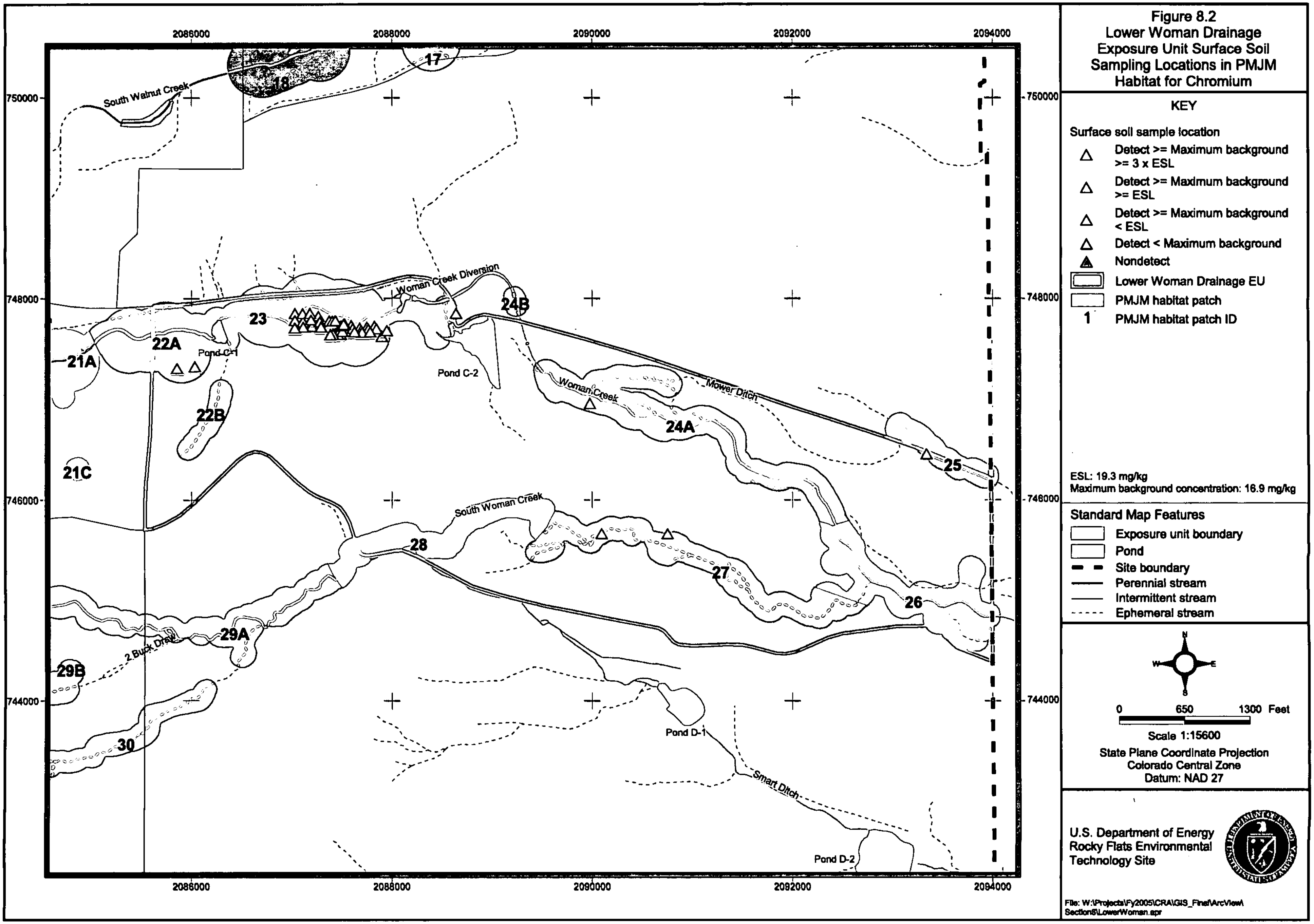
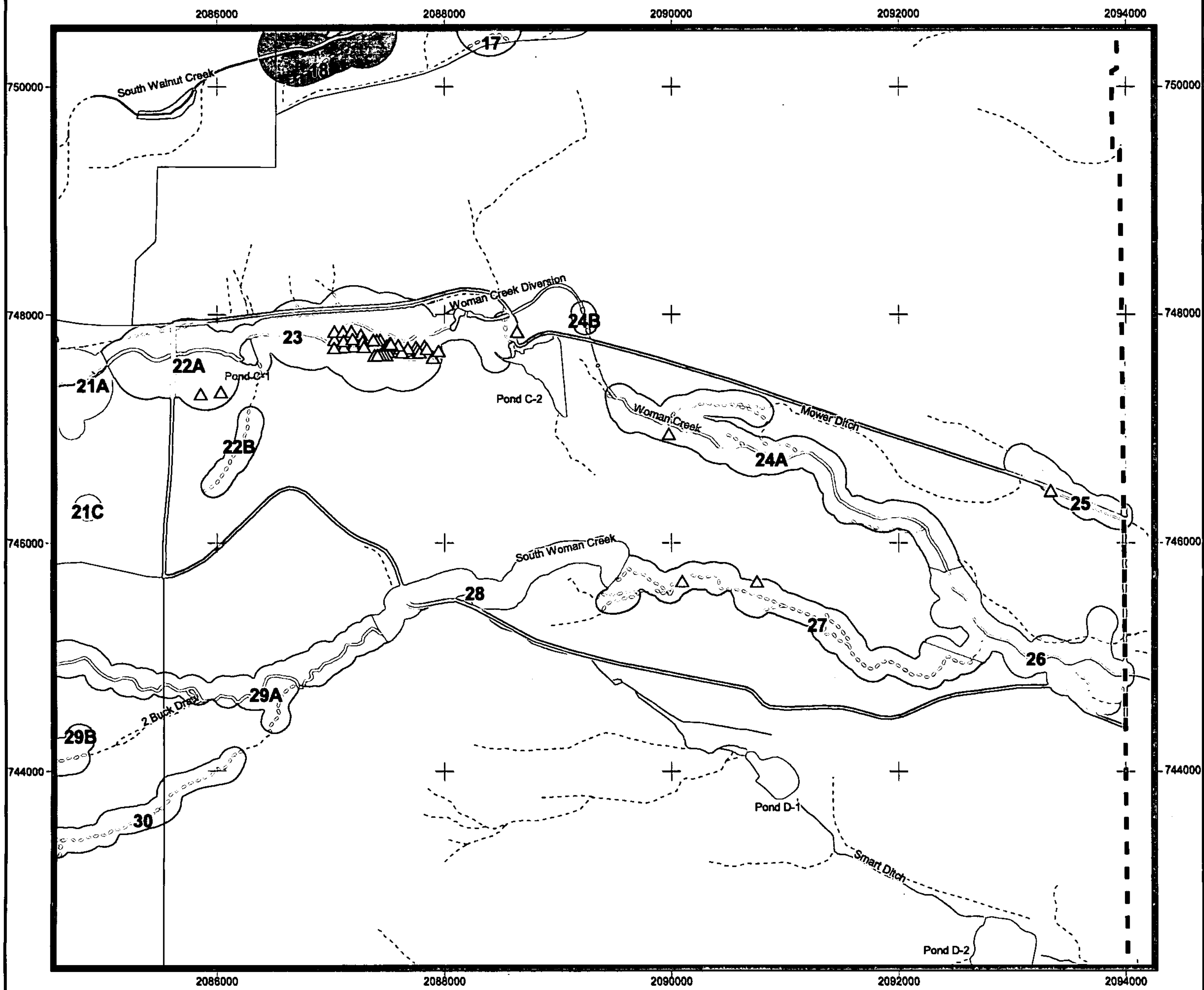


Figure 8.2
Lower Woman Drainage
Exposure Unit Surface Soil
Sampling Locations in PMJM
Habitat for Chromium

109

Figure 8.3
Lower Woman Drainage Exposure Unit Surface Soil Sampling Locations in PMJM Habitat for Copper



KEY

Surface soil sample location

- △ Detect >= Maximum background >= 3 x ESL
- △ Detect >= Maximum background >= ESL
- △ Detect >= Maximum background < ESL
- △ Detect < Maximum background
- ▲ Nondetect
- Lower Woman Drainage EU
- PMJM habitat patch
- 1 PMJM habitat patch ID

ESL: 94.97 mg/kg
Maximum background concentration: 16 mg/kg

Standard Map Features

- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N
W
E
S

0 650 1300 Feet

Scale 1:15600

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

File: W:\Projects\Fy2005\CRA\GIS_Final\ArcView\Section8\LowerWoman.apr

110

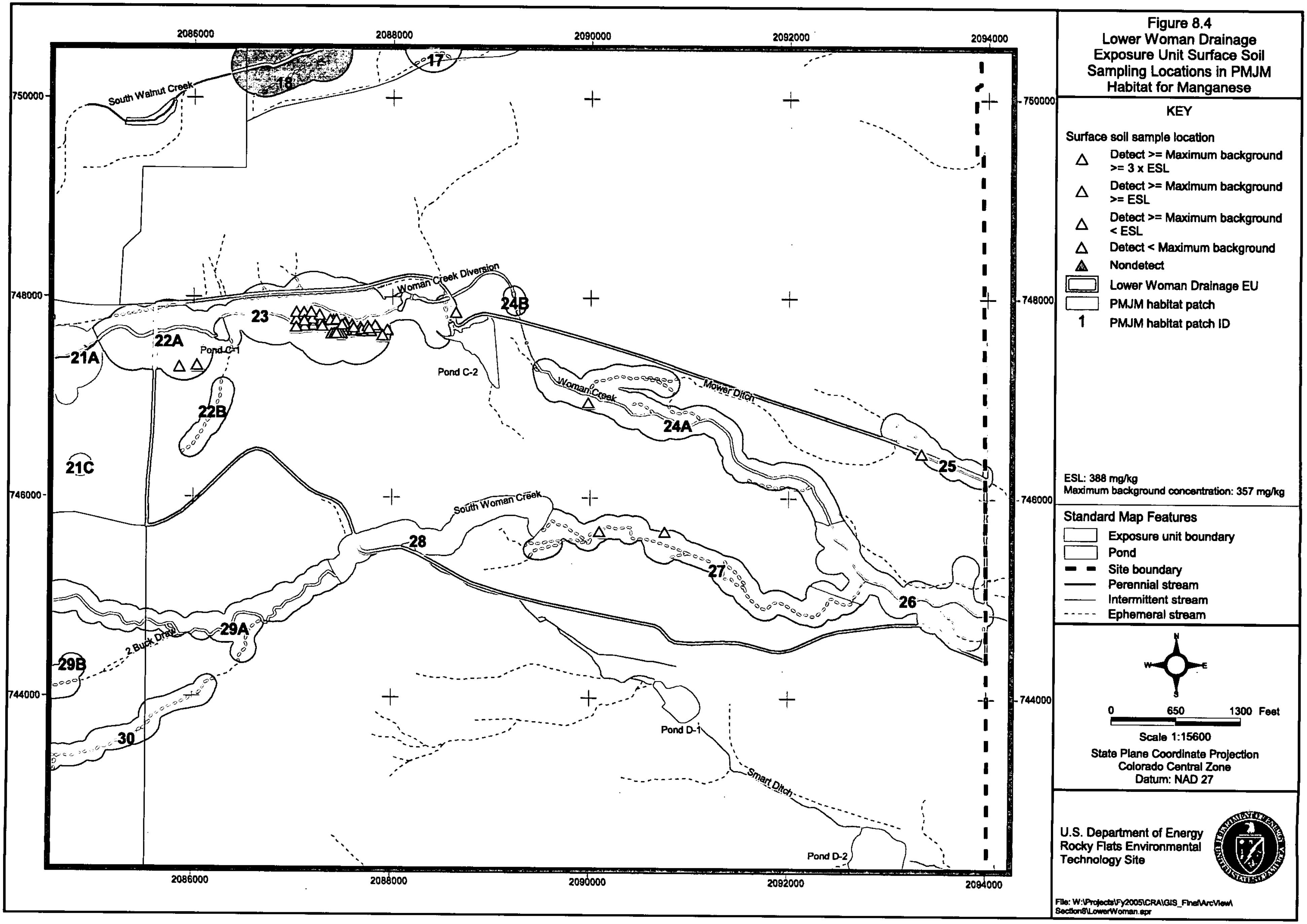


Figure 8.4
Lower Woman Drainage
Exposure Unit Surface Soil
Sampling Locations in PMJM
Habitat for Manganese
KEY
Surface soil sample location
Detect >= Maximum background >= 3 x ESL
Detect >= Maximum background >= ESL
Detect >= Maximum background < ESL
Detect < Maximum background
Nondetect
Lower Woman Drainage EU
PMJM habitat patch
1 PMJM habitat patch ID
ESL: 388 mg/kg
Maximum background concentration: 357 mg/kg
Standard Map Features
Exposure unit boundary
Pond
Site boundary
Perennial stream
Intermittent stream
Ephemeral stream
N
W
E
S
0 650 1300 Feet
Scale 1:15600
State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27
U.S. Department of Energy
Rocky Flats Environmental
Technology Site
File: W:\Projects\Fy2005\CRA\GIS_Final\ArcView\Section8\LowerWoman.apr
2086000
2088000
2090000
2092000
2094000
750000
748000
746000
744000
South Walnut Creek
Woman Creek Diversion
Woman Creek
Mower Ditch
South Woman Creek
2 Buck Draw
Smart Ditch
Pond C-1
Pond C-2
Pond D-1
Pond D-2
17
18
21A
21C
22A
22B
23
24A
24B
25
26
27
28
29A
29B
30

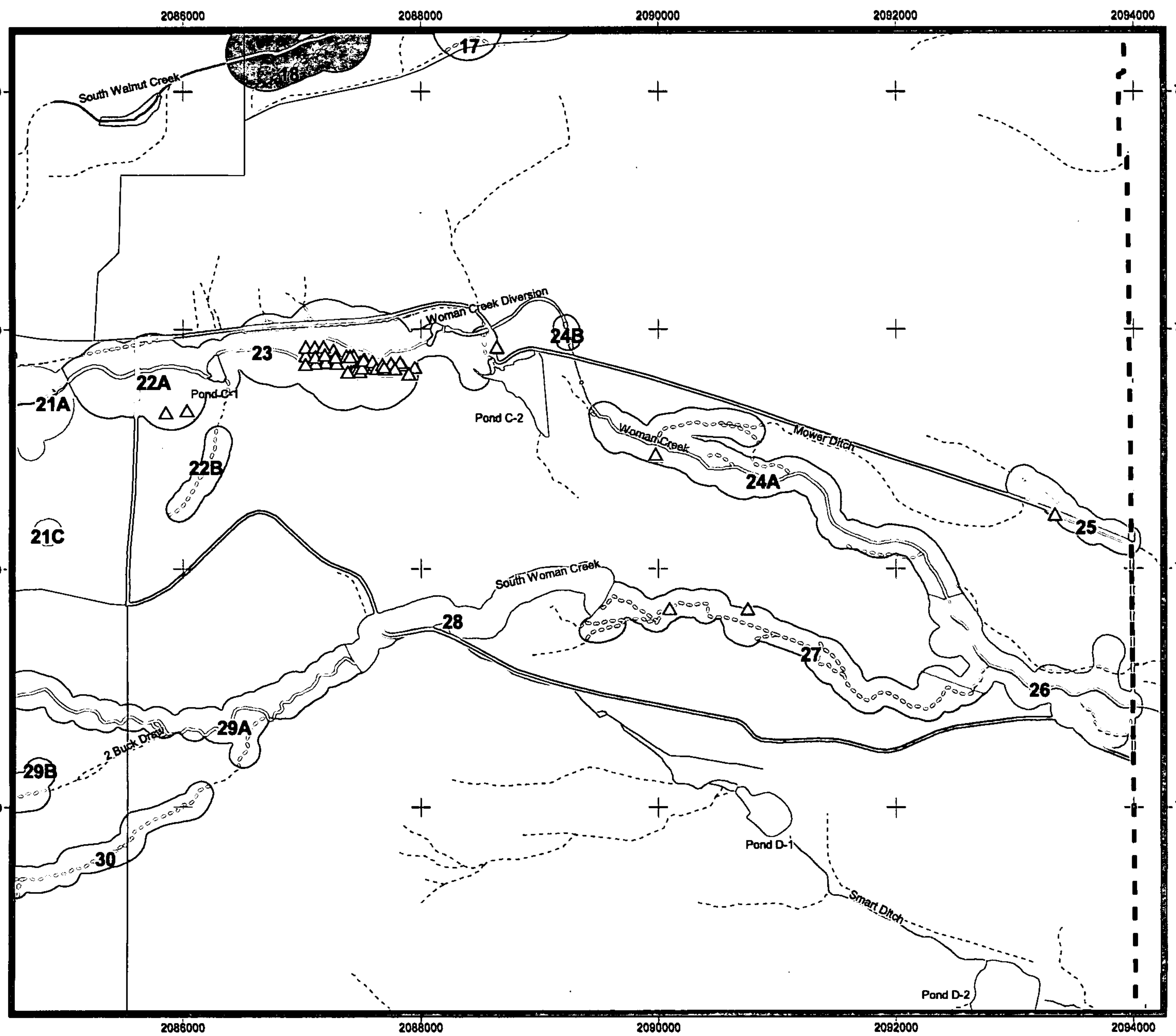


Figure 8.5
Lower Woman Drainage Exposure Unit Surface Soil Sampling Locations in PMJM Habitat for Nickel

KEY

Surface soil sample location
- Detect >= Maximum background >= 3 x ESL
- Detect >= Maximum background >= ESL
- Detect >= Maximum background < ESL
- Detect < Maximum background
- Nondetect
- Lower Woman Drainage EU
- PMJM habitat patch
- 1 PMJM habitat patch ID

ESL: 0.51 mg/kg
Maximum background concentration: 14.0 mg/kg

Standard Map Features
- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N
W E
S

0 650 1300 Feet

Scale 1:15600

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental
Technology Site

File: W:\Projects\Fy2005\CRA\GIS_Final\ArcView\Section8\LowerWoman.apr

112

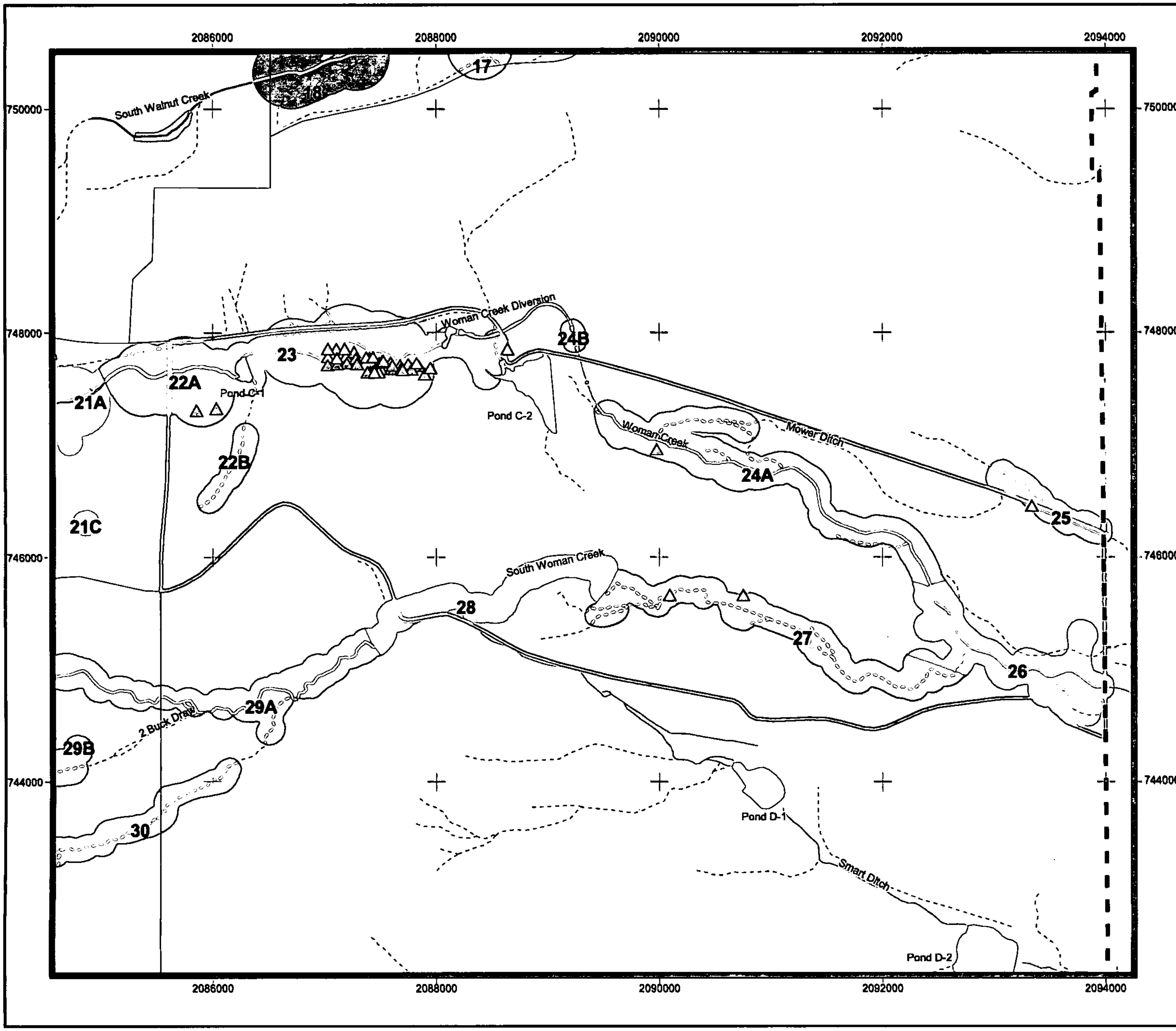


Figure 8.6
Lower Woman Drainage Exposure Unit Surface Soil Sampling Locations in PMJM Habitat for Selenium

KEY

Surface soil sample location

- Detect >= Maximum background >= 3 x ESL
- Detect >= Maximum background >= ESL
- Detect >= Maximum background < ESL
- Detect < Maximum background
- Nondetect
- Lower Woman Drainage EU
- PMJM habitat patch
- 1 PMJM habitat patch ID

ESL: 0.42 mg/kg
Maximum background concentration: 1.4 mg/kg

Standard Map Features

- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N
W E
S

0 650 1300 Feet

Scale 1:15600

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

File: W:\Projects\Fy2005\CRA\GIS_Final\ArcView\Section8\LowerWoman.apr

113

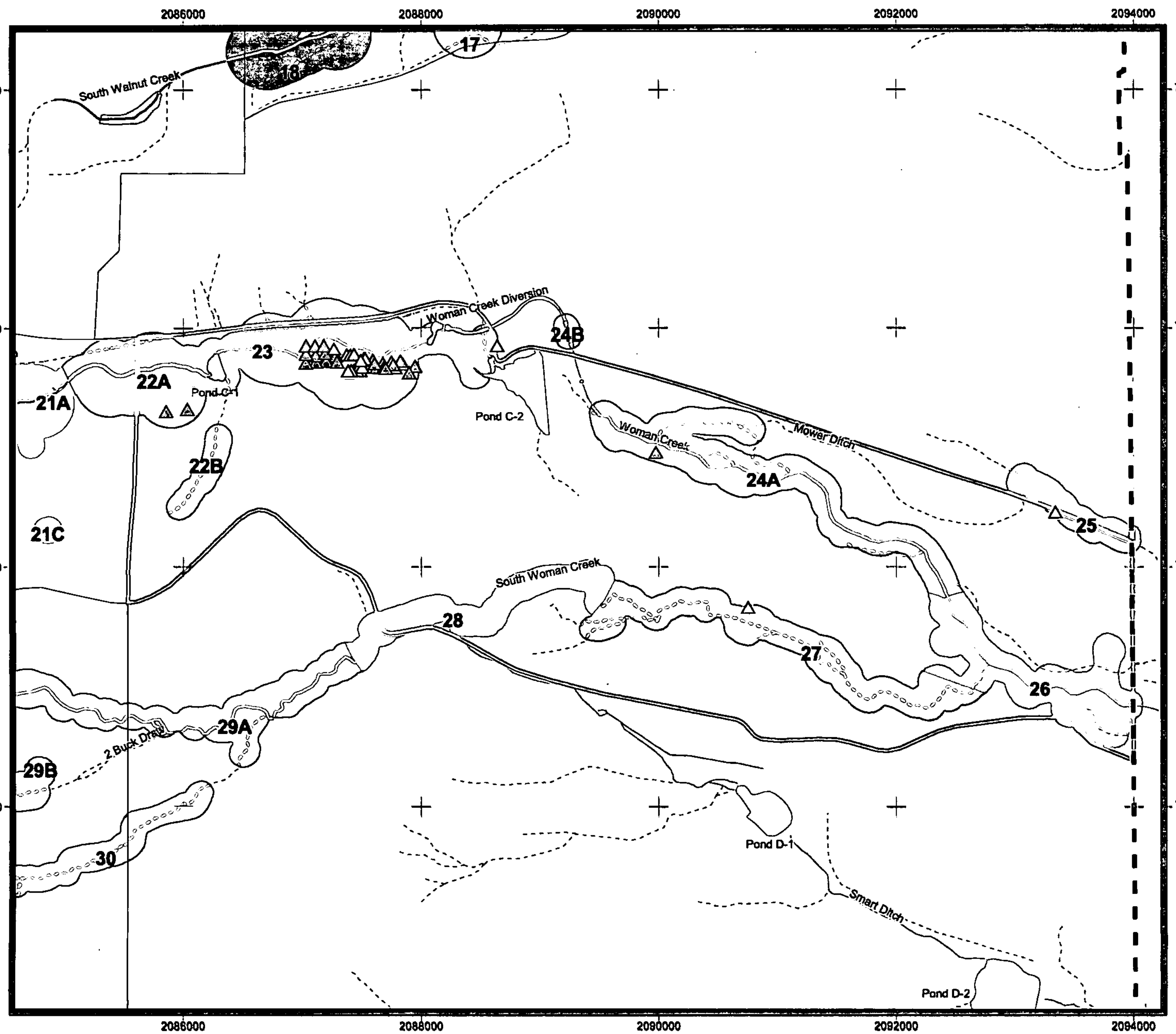


Figure 8.7
Lower Woman Drainage Exposure Unit Surface Soil Sampling Locations in PMJM Habitat for Tin

KEY

Surface soil sample location
- Detect >= Maximum background >= 3 x ESL
- Detect >= Maximum background >= ESL
- Detect >= Maximum background < ESL
- Detect < Maximum background
- Nondetect
- Lower Woman Drainage EU
- PMJM habitat patch
- 1 PMJM habitat patch ID

ESL: 4.21 mg/kg
Maximum background concentration: N/A

Standard Map Features
- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N E S W

0 650 1300 Feet

Scale 1:15600

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

File: W:\Projects\Fy2005\CRA\GIS_Final\ArcView\Section8\LowerWoman.apr

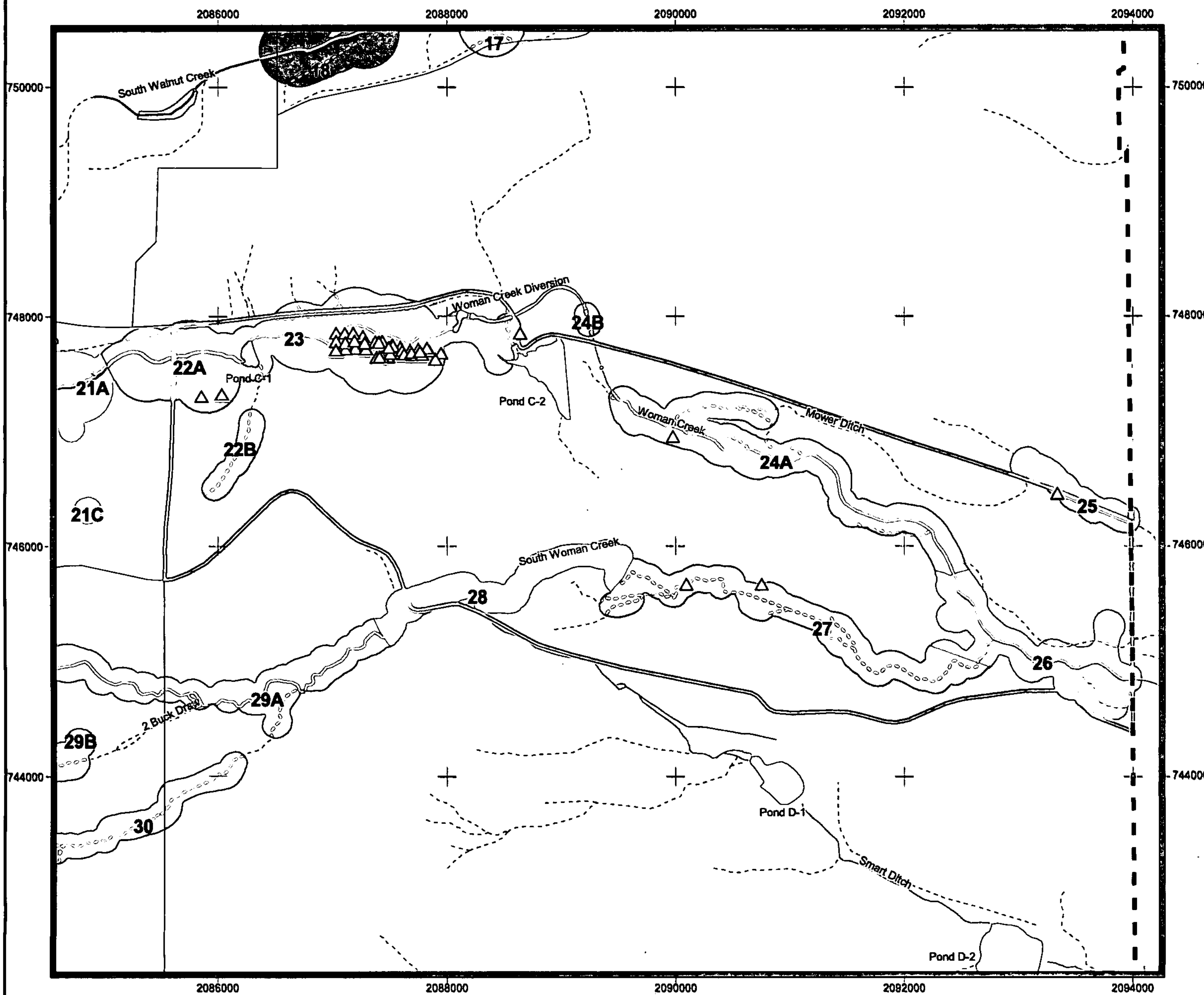


Figure 8.8
Lower Woman Drainage Exposure Unit Surface Soil Sampling Locations in PMJM Habitat for Vanadium

KEY

Surface soil sample location
- Detect >= Maximum background >= 3 x ESL
- Detect >= Maximum background >= ESL
- Detect >= Maximum background < ESL
- Detect < Maximum background
- Nondetect
- Lower Woman Drainage EU
- PMJM habitat patch
- 1 PMJM habitat patch ID

ESL: 21.6 mg/kg
Maximum background concentration: 45.8 mg/kg

Standard Map Features
- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N W E S

0 650 1300 Feet

Scale 1:15600

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental
Technology Site

File: W:\Projects\Fy2005\CRA\GIS_Final\ArcView\Section8\LowerWoman.apr

115

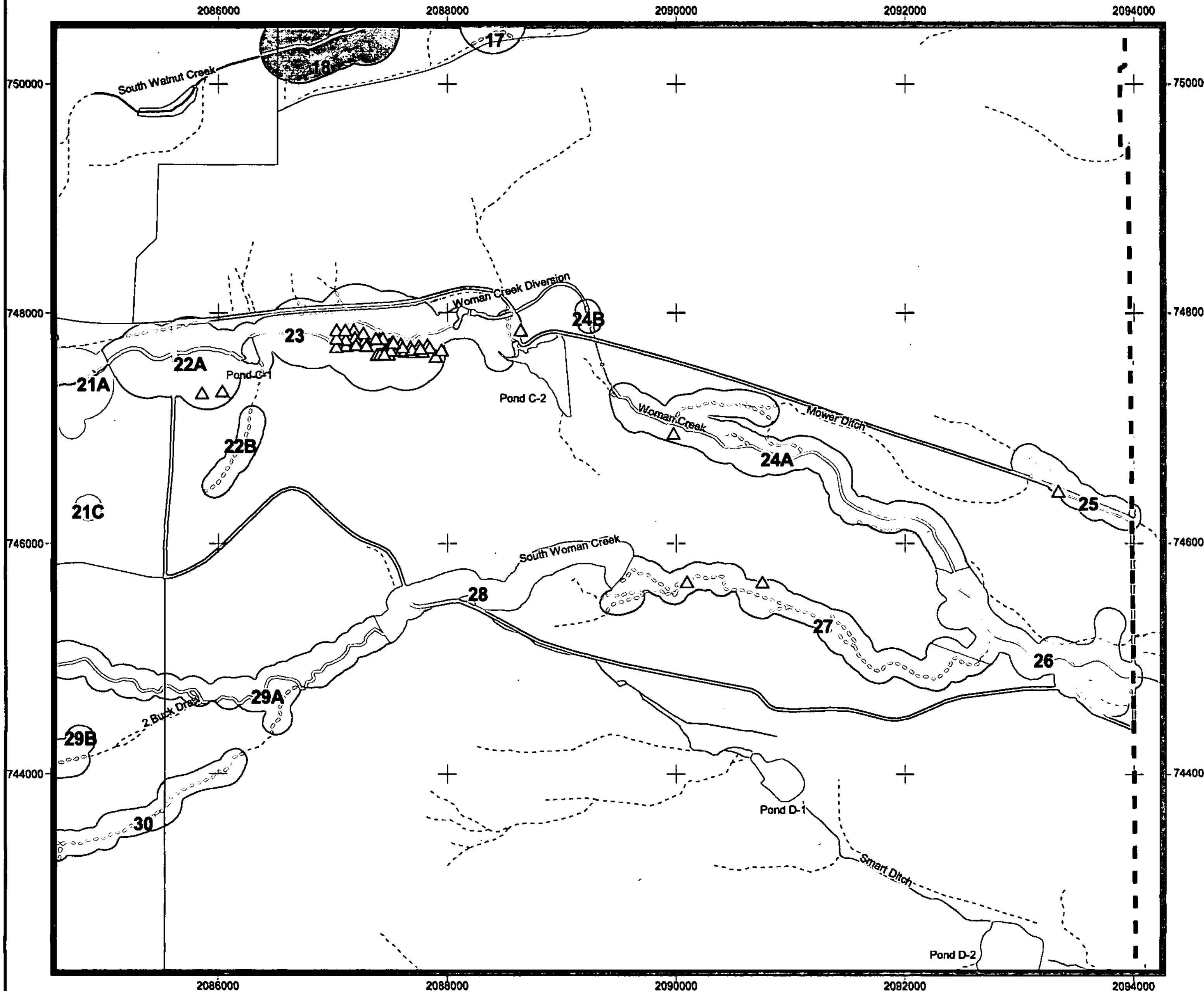


Figure 8.9
Lower Woman Drainage Exposure Unit Surface Soil Sampling Locations in PMJM Habitat for Zinc

KEY

Surface soil sample location

- Detect >= Maximum background >= 3 x ESL
- Detect >= Maximum background >= ESL
- Detect >= Maximum background < ESL
- Detect < Maximum background
- Nondetect
- Lower Woman Drainage EU
- PMJM habitat patch
- 1 PMJM habitat patch ID

ESL: 6.4 mg/kg
Maximum background concentration: 75.9 mg/kg

Standard Map Features

- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N W E S

0 650 1300 Feet

Scale 1:15600

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

File: W:\Projects\Fy2005\CRA\GIS_Final\ArcView\Section8\LowerWoman.apr

1/6

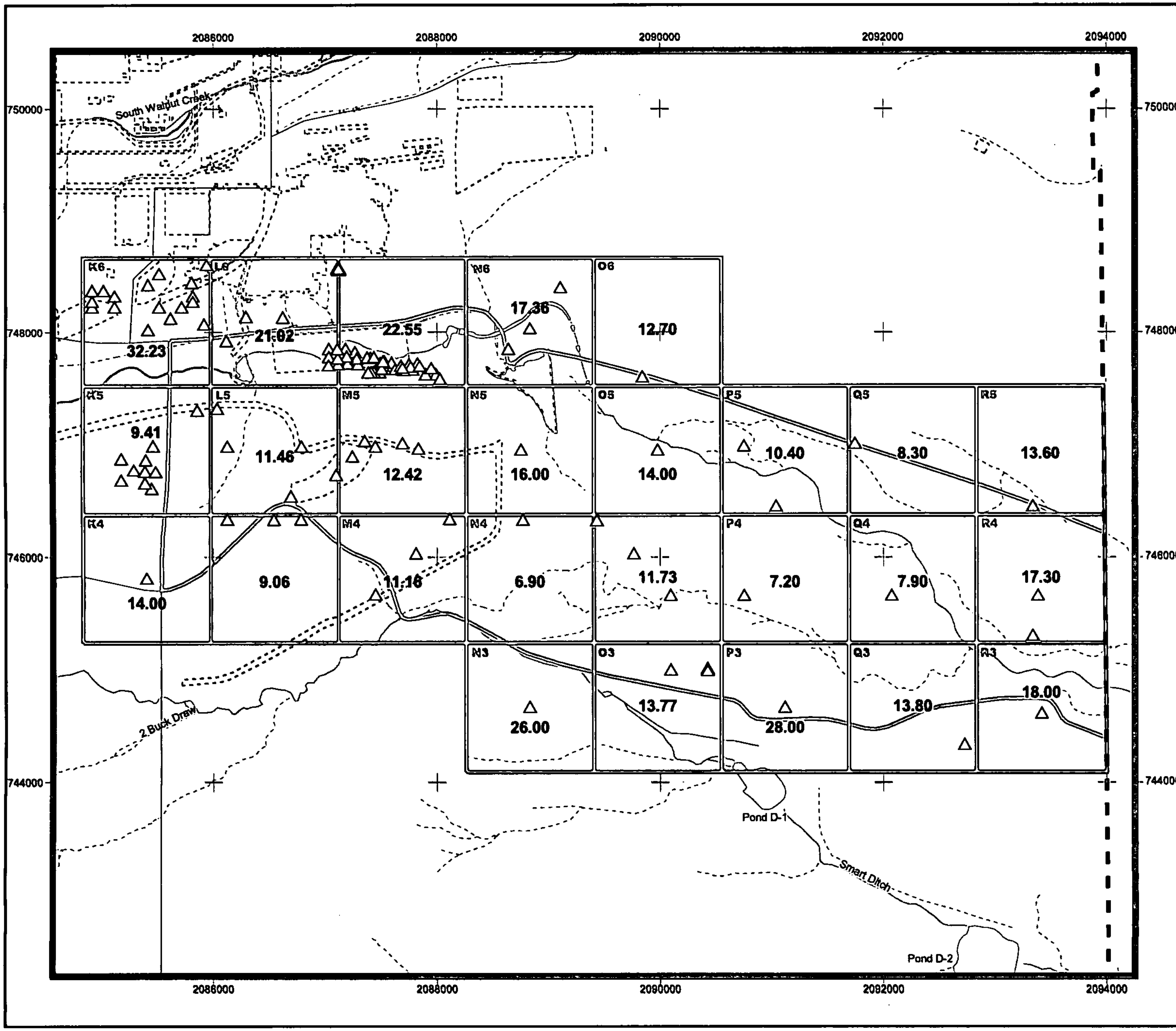


Figure 10.1
Lower Woman Drainage Exposure Unit Sample-by-Sample Comparison to the Limiting ESL - Chromium

KEY

Surface soil sample location

- Detect >= 10 x ESL
- Detect >= ESL < 10 x ESL
- Detect < ESL
- Nondetect
- Lower Woman Drainage EU
- 30-acre grid
- Historical IHSS/PAC
- A1 Grid cell ID

ESL: 1.34 mg/kg
Receptor: Mourning Dove (Insectivore)
95th UCL background: 12.3 mg/kg
Maximum background concentration: 16.9 mg/kg

Standard Map Features

- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N W E S

0 650 1300 Feet
Scale 1:15600

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

File: W:\Projects\Fy2005\CRA\GIS_Final\ArcView\Section10\LowerWoman.apr

117

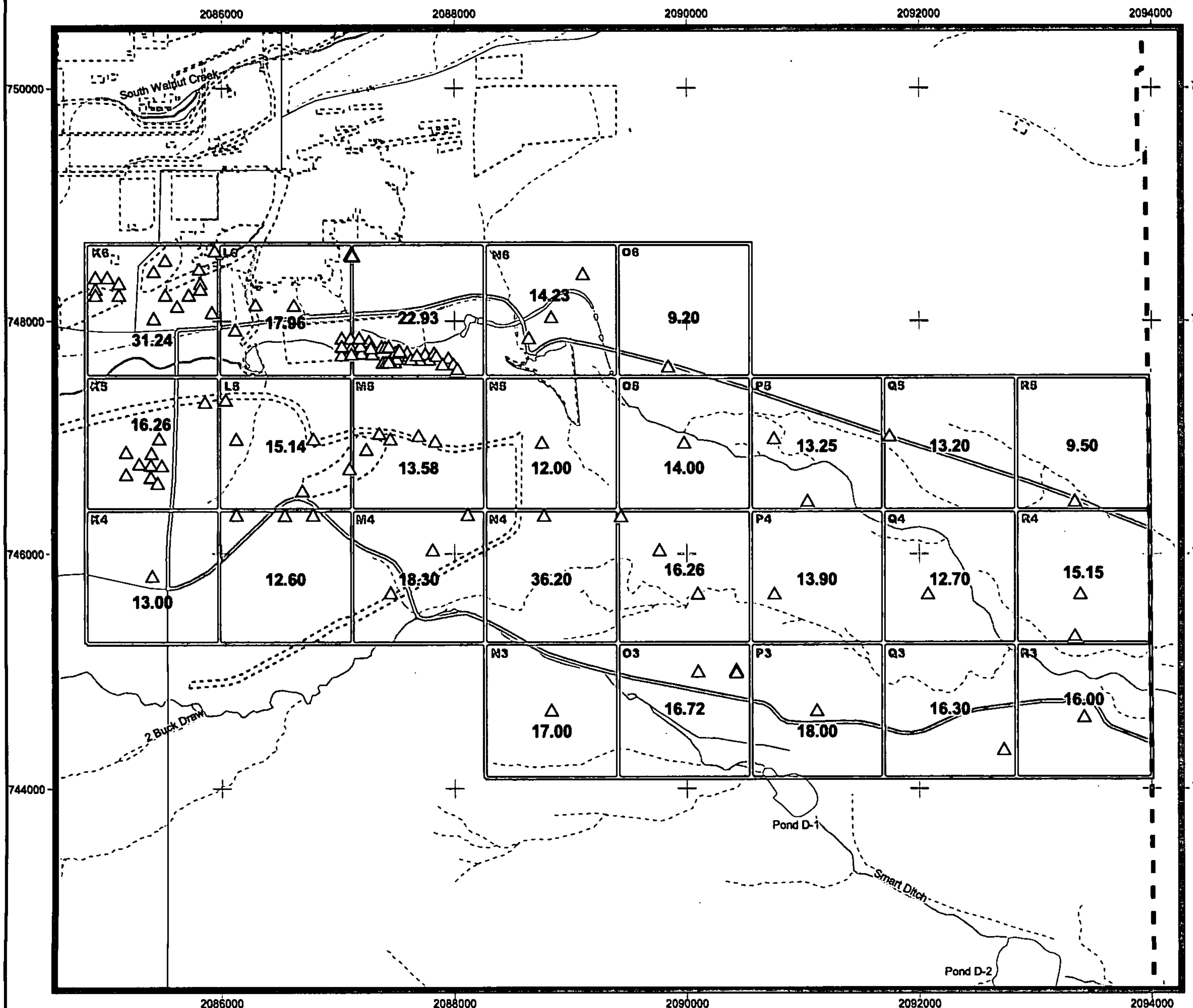


Figure 10.2
Lower Woman Drainage Exposure Unit Sample-by-Sample Comparison to the Limiting ESL - Copper

KEY

Surface soil sample location
- △ Detect >= 10 x ESL
- △ Detect >= ESL < 10 x ESL
- △ Detect < ESL
- △ Nondetect
- Lower Woman Drainage EU
- 30-acre grid
- Historical IHSS/PAC
- A1 Grid cell ID

ESL: 8.25 mg/kg
Receptor: Mourning Dove (Insectivore)
95th UCL background: 14 mg/kg
Maximum background concentration: 16 mg/kg

Standard Map Features
- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N W E S

0 650 1300 Feet

Scale 1:15600

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

File: W:\Projects\Fy2005\CRA\GIS_Final\ArcView\Section10\LowerWoman.apr

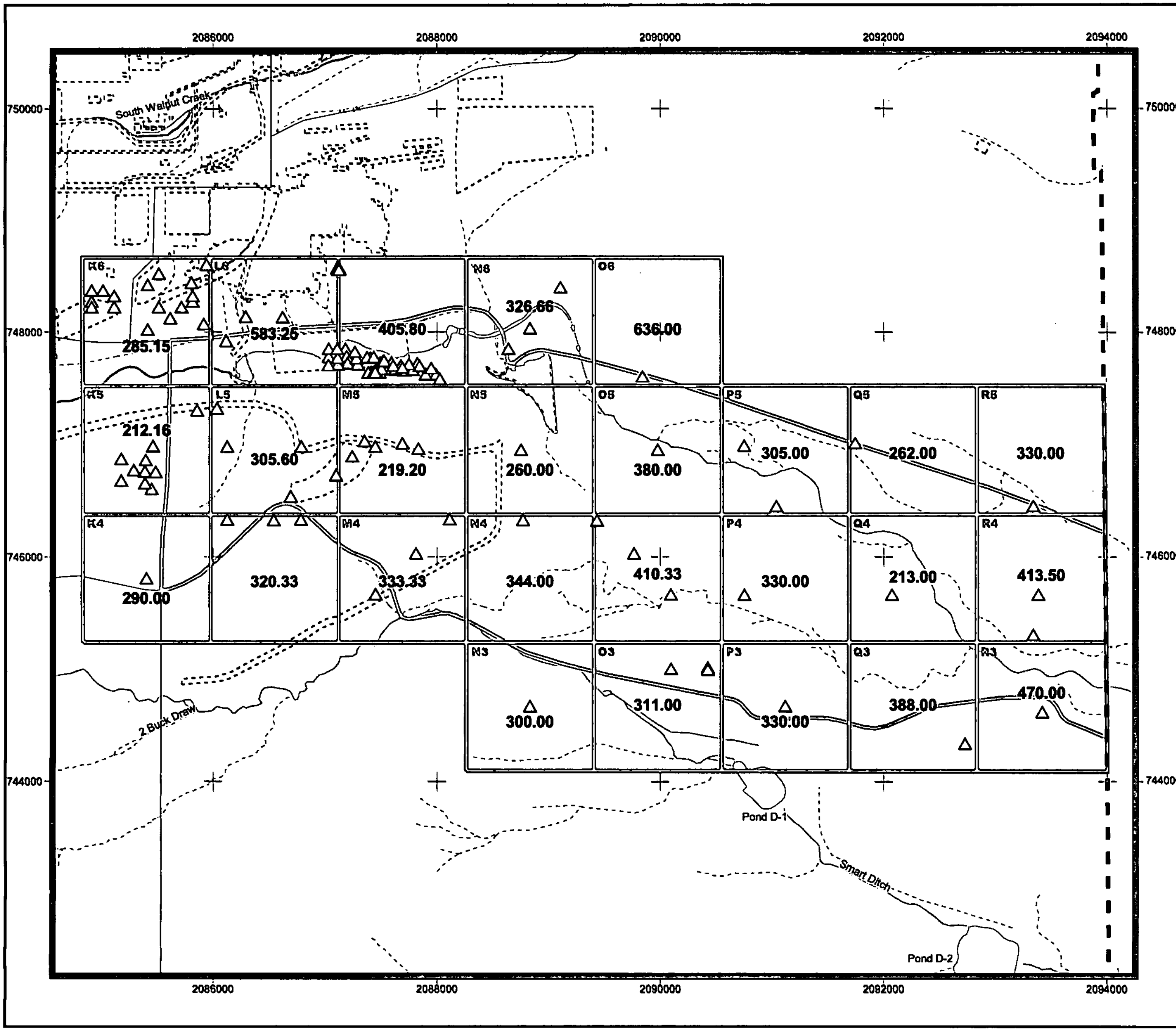


Figure 10.3
Lower Woman Drainage Exposure Unit Sample-by-Sample Comparison to the Limiting ESL - Manganese

KEY

Surface soil sample location
- Detect >= 10 x ESL
- Detect >= ESL < 10 x ESL
- Detect < ESL
- Nondetect
- Lower Woman Drainage EU
- 30-acre grid
- Historical IHSS/PAC
- A1 Grid cell ID

ESL: 486 mg/kg
Receptor: Deer Mouse (Herbivore)
95th UCL background: 262 mg/kg
Maximum background concentration: 357 mg/kg

Standard Map Features
- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N W E S

0 650 1300 Feet

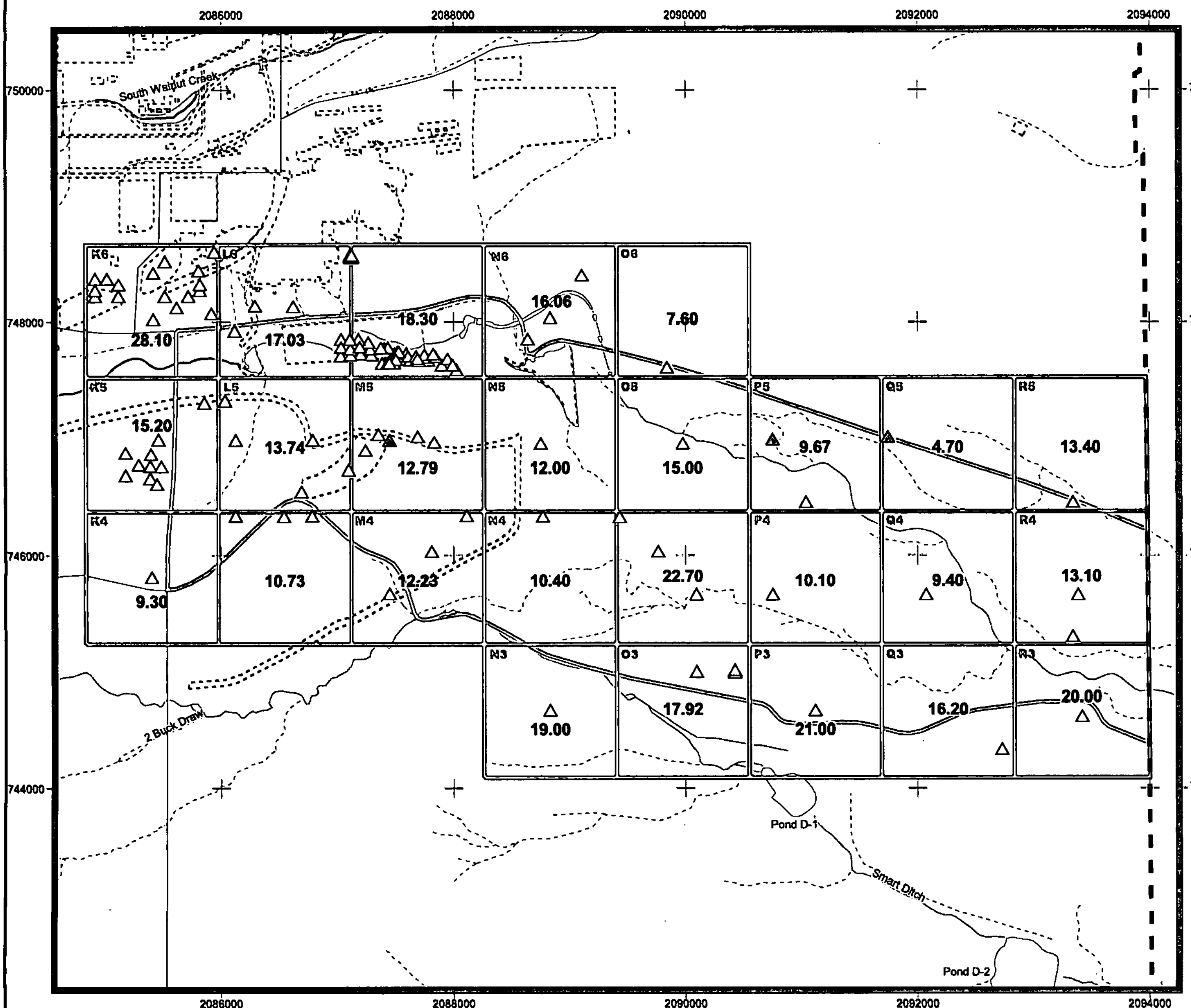
Scale 1:15600

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

File: W:\Projects\Fy2005\CRA\GIS_Final\ArcView\Section10\LowerWoman.apr

Figure 10.4
Lower Woman Drainage Exposure Unit Sample-by-Sample Comparison to the Limiting ESL - Nickel



KEY

Surface soil sample location
- Detect >= 10 x ESL
- Detect >= ESL < 10 x ESL
- Detect < ESL
- Nondetect
- Lower Woman Drainage EU
- 30-acre grid
- Historical IHSS/PAC
- A1 Grid cell ID

ESL: 0.431 mg/kg
Receptor: Deer Mouse (Insectivore)
95th UCL background: 10.6 mg/kg
Maximum background concentration: 14 mg/kg

Standard Map Features
- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N W E S

0 650 1300 Feet

Scale 1:15600

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

File: W:\Projects\Fy2005\CRA\GIS_Final\ArcView\Section10\LowerWoman.apr

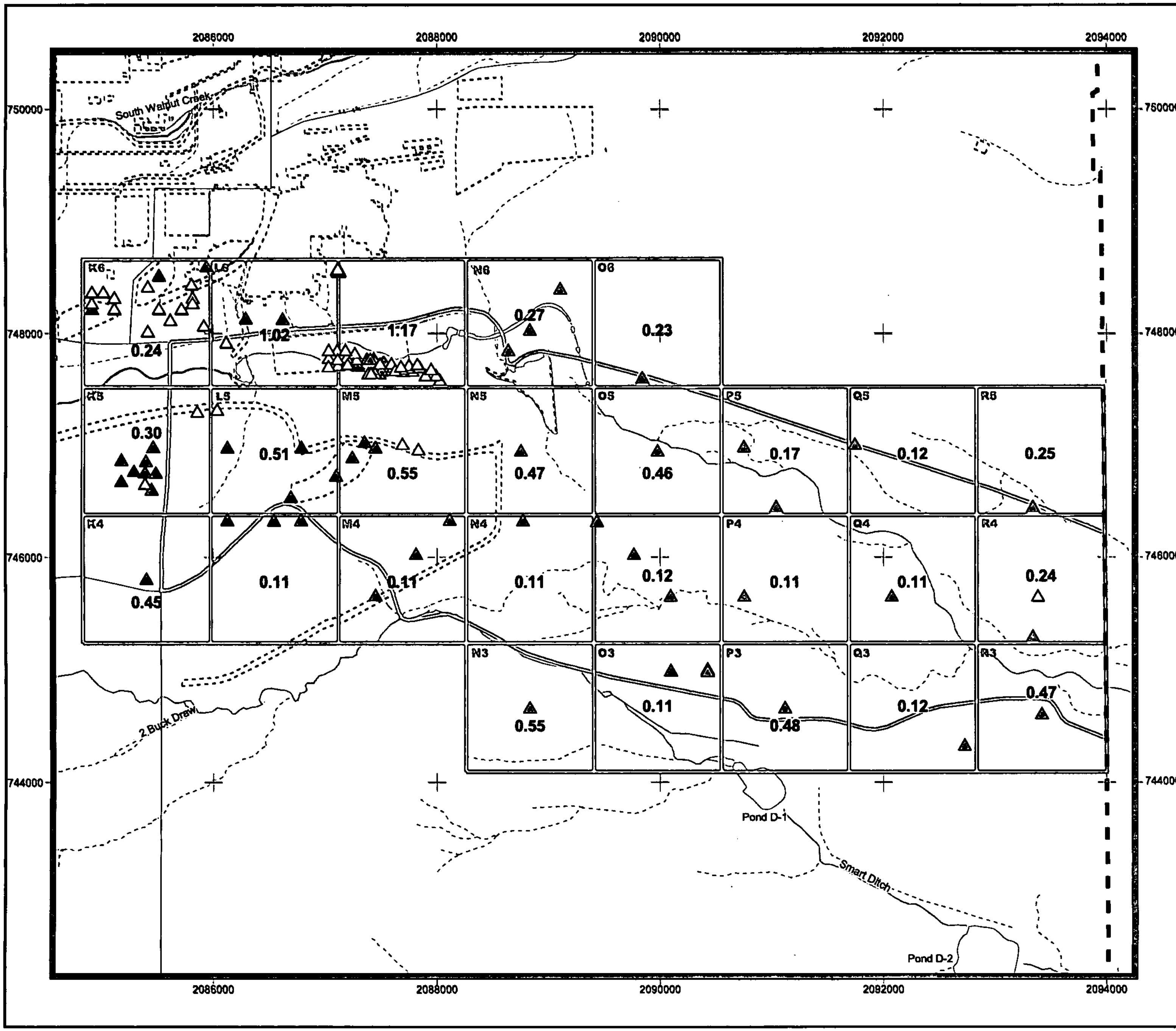


Figure 10.5
Lower Woman Drainage Exposure Unit Sample-by-Sample Comparison to the Limiting ESL - Thallium

KEY

Surface soil sample location
- Detect >= 10 x ESL
- Detect >= ESL < 10 x ESL
- Detect < ESL
- Nondetect
- Lower Woman Drainage EU
- 30-acre grid
- Historical IHSS/PAC
- A1 Grid cell ID

ESL: 1 mg/kg
Receptor: Terrestrial Plants
95th UCL background: 0.421 mg/kg
Maximum background concentration: N/A

Standard Map Features
- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N W E S

0 650 1300 Feet

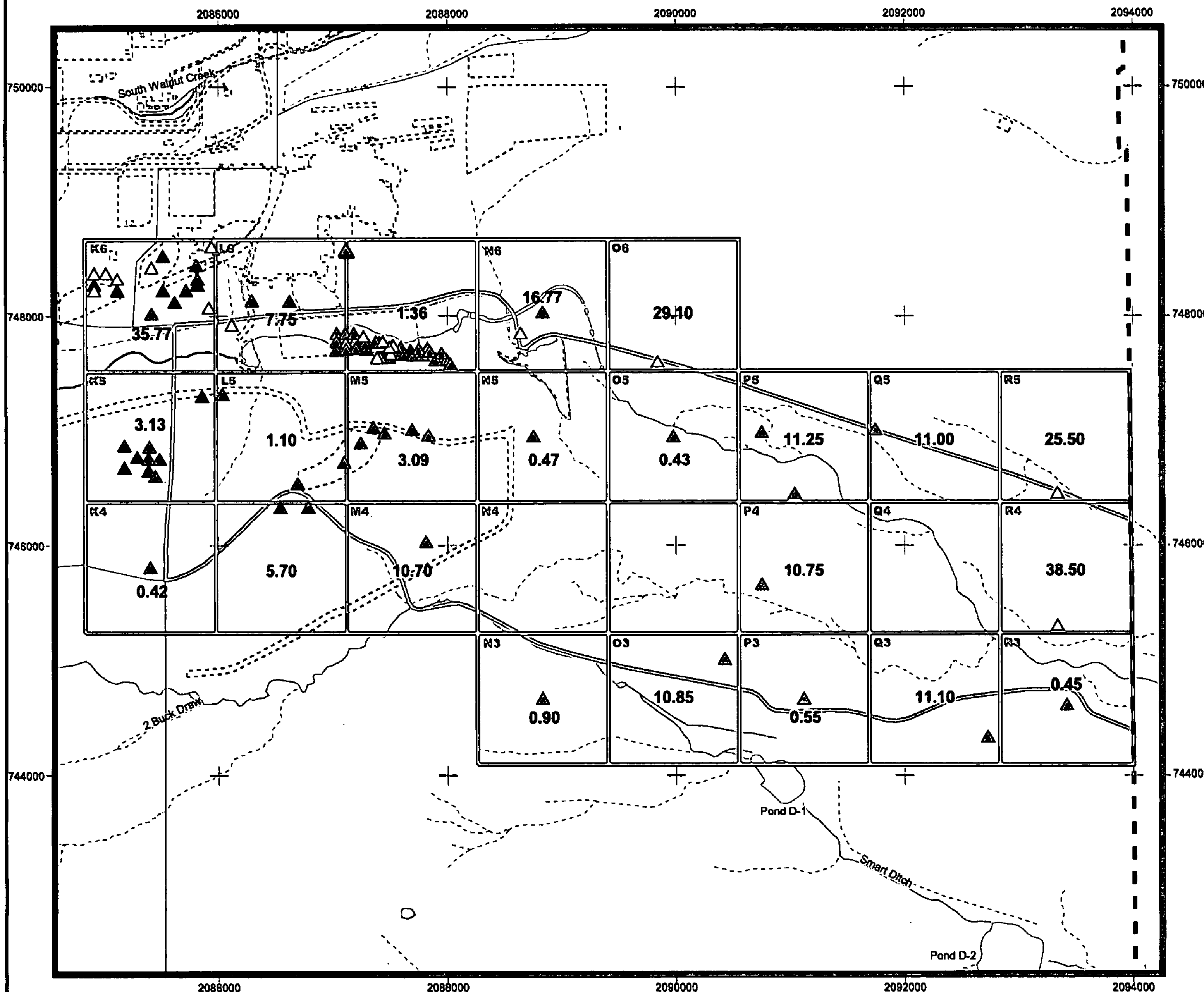
Scale 1:15600

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

File: W:\Projects\Fy2005\CRA\GIS_Final\ArcView\Section10\LowerWoman.apr

Figure 10.6
Lower Woman Drainage Exposure Unit Sample-by-Sample Comparison to the Limiting ESL - Tin



KEY

Surface soil sample location

- Detect >= 10 x ESL
- Detect >= ESL < 10 x ESL
- Detect < ESL
- Nondetect
- Lower Woman Drainage EU
- 30-acre grid
- Historical IHSS/PAC
- A1 Grid cell ID

ESL: 2.9 mg/kg
Receptor: Mourning Dove (Insectivore)
95th UCL background: 2.22 mg/kg
Maximum background concentration: N/A

Standard Map Features

- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N E S W

0 650 1300 Feet

Scale 1:15600

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

File: W:\Projects\Fy2005\CRA\GIS_Final\ArcView\Section10\LowerWoman.apr

122

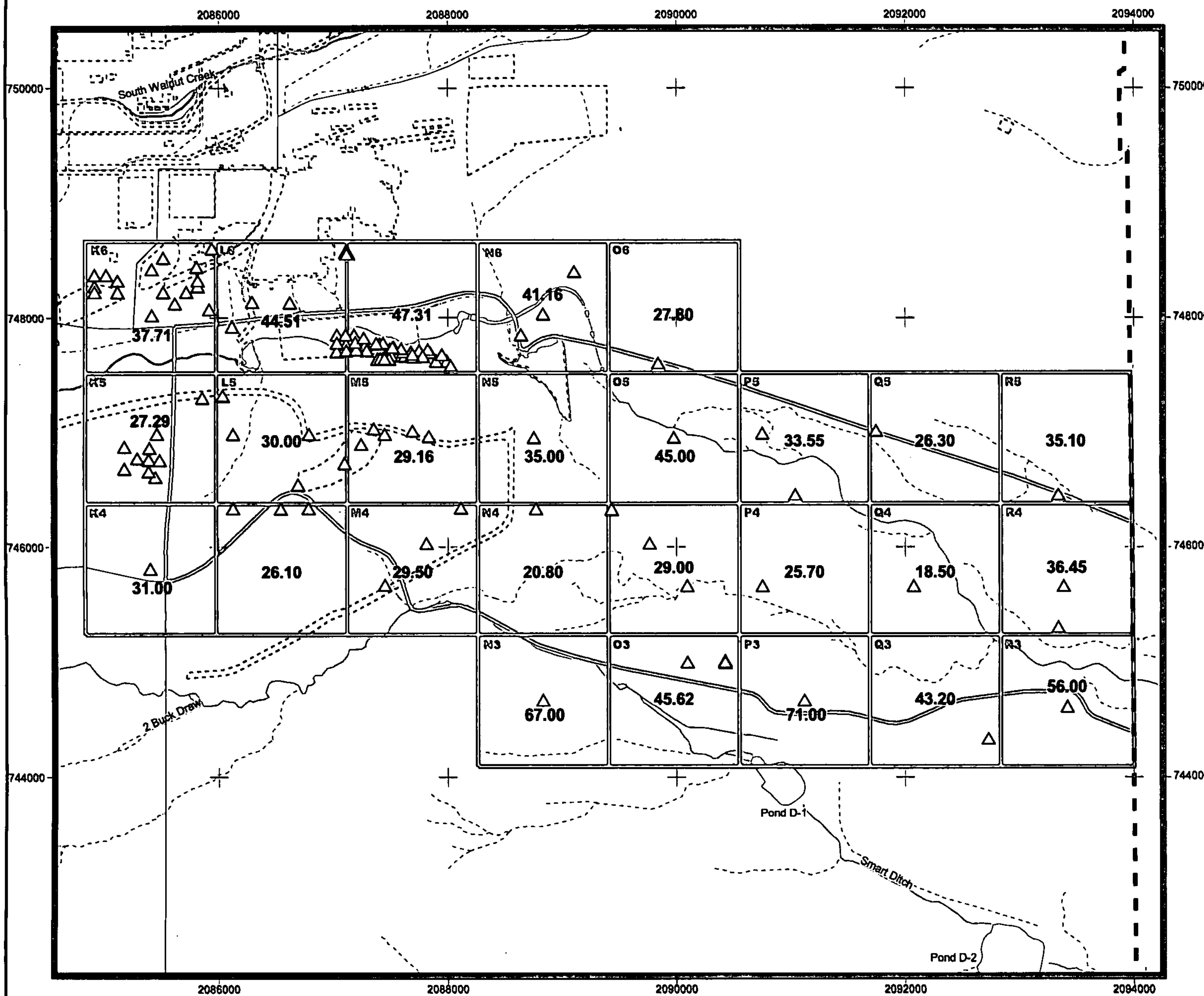


Figure 10.7
Lower Woman Drainage Exposure Unit Sample-by-Sample Comparison to the Limiting ESL - Vanadium

KEY

Surface soil sample location
- Detect >= 10 x ESL
- Detect >= ESL < 10 x ESL
- Detect < ESL
- Nondetect
- Lower Woman Drainage EU
- 30-acre grid
- Historical IHSS/PAC
- A1 Grid cell ID

ESL: 63.7 mg/kg
Receptor: Deer Mouse (Insectivore)
95th UCL background: 30.7 mg/kg
Maximum background concentration: 45.8 mg/kg

Standard Map Features
- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N W E S

0 650 1300 Feet

Scale 1:15600

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

File: W:\Projects\Fy2005\CRA\GIS_Final\ArcView\Section10\LowerWoman.apr

COMPREHENSIVE RISK ASSESSMENT

LOWER WOMAN DRAINAGE EXPOSURE UNIT

VOLUME 11: ATTACHMENT 1

Detection Limit Screen

TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS ii

1.0 EVALUATION OF DETECTION LIMITS FOR NONDETECTED ANALYTES IN THE LOWER WOMAN DRAINAGE EXPOSURE UNIT . 1

1.1 Comparison of Maximum Detection Limits for Nondetected Analytes to Preliminary Remediation Goals 1

1.1.1 Surface Soil/Surface Sediment 1

1.1.2 Subsurface Soil/Subsurface Sediment 2

1.2 Comparison of Maximum Reported Results for Nondetected Analytes to Ecological Screening Levels 2

1.2.1 Surface Soil 2

1.2.2 Subsurface Soil 2

LIST OF TABLES

Table A1.1 Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency less than 5 percent in Surface Soil/Surface Sediment

Table A1.2 Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency less than 5 percent in Subsurface Soil/Subsurface Sediment

Table A1.3 Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency less than 5 percent in Surface Soil

Table A1.4 Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency less than 5 percent in Subsurface Soil

ACRONYMS AND ABBREVIATIONS

µg/kg	micrograms per kilogram
ERA	Ecological Risk Assessment
ESL	ecological screening level
HHRA	Human Health Risk Assessment
LWOEU	Lower Woman Drainage Exposure Unit
NOAEL	No observed adverse effect level
PRG	preliminary remediation goal
WRW	wildlife refuge worker

1.0 EVALUATION OF DETECTION LIMITS FOR NONDETECTED ANALYTES IN THE LOWER WOMAN DRAINAGE EXPOSURE UNIT

The detection limits for analytes that are either not detected or detected in less than 5 percent of the samples collected from the media used in the Human Health Risk Assessment (HHRA) or the Ecological Risk Assessment (ERA) are reviewed in this attachment. The detection limits for surface soil/surface sediment and subsurface soil/subsurface sediment samples are compared to human health preliminary remediation goals (PRGs) for the wildlife refuge worker (WRW). The detection limits for media evaluated in the ERA are compared to the minimum ecological screening level (ESL) for a variety of ecological receptors (surface soil) and the prairie dog no observed adverse effect level (NOAEL) ESL (subsurface soil). The results of these comparisons are presented in Tables A1.1 through A1.4.

Nondetects and the reported detection limits (referred to as "reported result" in the following sections of this attachment) are listed in these tables for each medium in the Lower Woman Drainage Exposure Unit (LWOEU) and compared to medium-specific human health PRGs for the WRW and ESLs for a variety of ecological receptors. Detection limits that exceed the respective PRGs and ESLs are noted and discussed.

Analytes that were not detected in any samples collected in each media are referred to as nondetected analytes. The nondetected chemicals are reported in this attachment at the lowest level at which the chemical may be accurately and reproducibly quantified, taking into account the sample characteristics, sample collection, sample preparation, and analytical adjustments.

1.1 Comparison of Maximum Detection Limits for Nondetected Analytes to Preliminary Remediation Goals

1.1.1 Surface Soil/Surface Sediment

The maximum reported results for four nondetected analytes and two analytes detected in less than 5 percent of samples in surface soil/surface sediment are greater than the PRG (Table A1.1). Therefore, there is some uncertainty associated with the reported results for these analytes in the LWOEU.

For 4,6-dinitro-2-methylphenol, dibenz(a,h)anthracene, dieldrin, hexachlorobenzene, n-nitroso-di-n-propylamine, and Aroclor-1260, the minimum reported value did not exceed the PRG. For dibenz(a,h)anthracene and n-nitroso-di-n-propylamine, the maximum reported result was approximately 5 times the PRG. For the remaining analytes, the maximum reported results were less than twice the PRG. The slight exceedance of the maximum reported results for 4,6-dinitro-2-methylphenol, dibenz(a,h)anthracene, dieldrin, hexachlorobenzene, n-nitroso-di-n-propylamine, and Aroclor-1260 compared to the PRGs is not expected to have significant impacts on the results of the risk assessment.

PRGs were not available for several nondetected organic analytes and organic analytes detected in less than 5 percent of samples in surface soil/surface sediment (Table A1.1). Because PRGs were available for most of the nondetected and detected in less than 5 percent organics in surface soil/surface sediment, and the maximum reported results for

125

these analytes were much lower than the PRGs, the lack of PRGs for less than half of the organics is unlikely to have a significant effect on the results of the risk assessment. In addition, the fact that no identified source exists for these analytes in the surface soil/surface sediment at the LWOEU, suggests there is an acceptable level of uncertainty associated with the reported results for these nondetected analytes.

1.1.2 Subsurface Soil/Subsurface Sediment

No nondetected analytes exceeded the PRG in subsurface soil/subsurface sediment (Table A1.2).

PRGs were not available for several nondetected organic analytes in subsurface soil/subsurface sediment (Table A1.2). Because PRGs were available for most of the nondetected organics in subsurface soil/subsurface sediment, and the maximum reported results for these analytes were much lower than the PRGs, the lack of PRGs for less than half of the organics is unlikely to have a significant effect on the results of the risk assessment. In addition, the fact that no identified source exists for these analytes in the subsurface soil/subsurface sediment at the LWOEU suggests there is an acceptable level of uncertainty associated with the reported results for these nondetected analytes.

1.2 Comparison of Maximum Reported Results for Nondetected Analytes to Ecological Screening Levels

1.2.1 Surface Soil

The maximum reported results for 27 nondetected analytes in surface soil are greater than the ESL (Table A1.3). Therefore, there is some uncertainty associated with the reported results for these analytes in the LWOEU.

The maximum reported result for 26 of the 27 analytes exceeds the ESL by less than one order of magnitude. For hexachlorobenzene the maximum reported result was 1,100 micrograms per kilogram (μg/kg) and the ESL was 7.73 μg/kg.

ESLs were not available for several nondetected organic analytes in surface soil (Table A1.3). Because ESLs were available for most of the nondetected organics in surface soil, and the maximum reported results for these analytes were much lower than the ESLs, the lack of ESLs for less than half of the organics is unlikely to have a significant effect on the results of the risk assessment. In addition, the fact that no identified source exists for these analytes in the surface soil at the LWOEU suggests there is an acceptable level of uncertainty associated with the reported results for these nondetected analytes.

1.2.2 Subsurface Soil

The minimum and maximum reported results for all nondetected analytes and analytes detected in less than 5 percent of samples in subsurface soil were below their respective ESLs (Table A1.4).

ESLs were not available for several of the organics and one inorganic in subsurface soil (Table A1.4). Because the maximum reported results for nondetected analytes with ESLs available were much lower than the ESLs, the lack of ESLs for several of the organics and one inorganic is not likely to have a significant effect on the results of the risk assessment.

1216

TABLES

Table A1.1

Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency less than 5 Percent in Surface Soil/Surface Sediment

Analyte	Range of Reported Results	Total Number of Results	PRG	Maximum Result[a] > PRG?
Inorganic (mg/kg)				
Uranium	1.4 - 18	56	333	No
Organic (µg/kg)				
1,1,1-Trichloroethane	6 - 16	15	9.18E+06	No
1,1,2,2-Tetrachloroethane	6 - 16	15	10,483	No
1,1,2-Trichloroethane	6 - 16	15	28,022	No
1,1-Dichloroethane	6 - 16	15	2.72E+06	No
1,1-Dichloroethene	6 - 16	15	17,366	No
1,2,3,4,7,8,9-HpCDF	0.00271 - 0.00271	1	N/A	UT
1,2,3,4,7,8-HxCDD	0.00271 - 0.00271	1	0.483	No
1,2,3,4,7,8-HxCDF	0.00271 - 0.00271	1	N/A	UT
1,2,3,6,7,8-HxCDD	0.00271 - 0.00271	1	0.483	No
1,2,3,6,7,8-HxCDF	0.00271 - 0.00271	1	N/A	UT
1,2,3,7,8,9-HxCDD	0.00271 - 0.00271	1	0.483	No
1,2,3,7,8,9-HxCDF	0.00271 - 0.00271	1	N/A	UT
1,2,3,7,8-PeCDF	0.00271 - 0.00271	1	N/A	UT
1,2,4-Trichlorobenzene	360 - 2,100	31	151,360	No
1,2-Dichlorobenzene	360 - 2,100	27	2.89E+06	No
1,2-Dichloroethane	6 - 16	15	13,270	No
1,2-Dichloroethene	6 - 16	15	999,783	No
1,2-Dichloropropane	6 - 16	15	38,427	No
1,3-Dichlorobenzene	360 - 2,100	31	3.33E+06	No
1,4-Dichlorobenzene	360 - 2,100	27	91,315	No
2,3,4,6,7,8-HxCDF	0.00271	1	N/A	UT
2,3,4,7,8-PeCDF	0.00271	1	N/A	UT
2,3,7,8-TCDD	0.00108	1	0.0248	No
2,3,7,8-TCDF	0.00108	1	N/A	UT
2,4,5-Trichlorophenol	1,200 - 10,000	31	8.01E+06	No
2,4,6-Trichlorophenol	360 - 2,100	31	272,055	No
2,4-Dichlorophenol	360 - 2,100	31	240,431	No
2,4-Dimethylphenol	360 - 2,100	31	1.60E+06	No
2,4-Dinitrophenol[b]	1,700 - 10,000	28	160,287	No
2,4-Dinitrotoluene	360 - 2,100	31	160,287	No
2,6-Dinitrotoluene	360 - 2,100	31	80,144	No
2-Chloronaphthalene	360 - 2,100	31	6.41E+06	No
2-Chlorophenol	360 - 2,100	31	555,435	No
2-Hexanone	12 - 32	14	N/A	UT
2-Methylnaphthalene	360 - 2,100	31	320,574	No
2-Methylphenol	360 - 2,100	31	4.01E+06	No
2-Nitroaniline	1,700 - 10,000	31	192,137	No
2-Nitrophenol	360 - 2,100	31	N/A	UT
3,3'-Dichlorobenzidine	720 - 4,100	31	6,667	No
3-Nitroaniline	1,700 - 10,000	31	N/A	UT
4,4'-DDD	17 - 200	28	15,528	No
4,4'-DDE	17 - 200	28	10,961	No
4,4'-DDT	17 - 200	28	10,927	No
4,6-Dinitro-2-methylphenol[b]	**1,700 - 10,000**	**30**	**8,014**	**Yes**
4-Bromophenyl-phenylether	360 - 2,100	31	N/A	UT
4-Chloro-3-methylphenol	360 - 3,100	31	N/A	UT

128

Table A1.1

Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency less than 5 Percent in Surface Soil/Surface Sediment

Analyte	Range of Reported Results	Total Number of Results	PRG	Maximum Result[a] > PRG?
4-Chloroaniline	360 - 3,100	31	320,574	No
4-Chlorophenyl-phenyl ether	360 - 2,100	31	N/A	UT
4-Nitroaniline	1,700 - 10,000	30	207,917	No
4-Nitrophenol	1,700 - 10,000	31	641,148	No
Acenaphthylene	360 - 2,100	31	N/A	UT
Aldrin[b]	8.6 - 99	27	176	No
alpha-BHC	8.6 - 99	28	570	No
alpha-Chlordane[b]	86 - 990	27	10,261	No
Ametryne	50	1	N/A	UT
Aroclor-1016	58 - 990	32	1,349	No
Aroclor-1221	58 - 990	32	1,349	No
Aroclor-1232	58 - 990	32	1,349	No
Aroclor-1242	58 - 990	32	1,349	No
Aroclor-1248	58 - 990	32	1,349	No
Aroclor-1260	**58 - 2,000**	**32**	**1,349**	**Yes**
Atraton	50	1	N/A	UT
Atrazine	50	1	13,636	No
Benzene	6 - 16	15	23,563	No
Benzo(g,h,i)perylene[b]	360 - 2,100	30	N/A	UT
Benzyl Alcohol	360 - 3,100	31	2.40E+07	No
beta-BHC[b]	8.6 - 99	27	1,995	No
beta-Chlordane	86 - 270	11	10,261	No
bis(2-Chloroethoxy) methane	360 - 2,100	31	N/A	UT
bis(2-Chloroethyl) ether	360 - 2,100	31	3,767	No
bis(2-Chloroisopropyl) ether	360 - 2,100	31	59,301	No
Bromodichloromethane	6 - 16	15	67,070	No
Bromoform	6 - 16	15	419,858	No
Bromomethane	12 - 32	15	20,959	No
Butylbenzylphthalate[b]	360 - 2,100	30	1.60E+07	No
Carbon Disulfide	6 - 16	15	1.64E+06	No
Carbon Tetrachloride	6 - 16	15	8,446	No
Chlorobenzene	6 - 16	15	666,523	No
Chloroethane	12 - 32	15	1.43E+06	No
Chloroform	6 - 16	15	7,850	No
Chloromethane	15 - 32	13	115,077	No
cis-1,3-Dichloropropene	6 - 16	15	19,432	No
delta-BHC[b]	8.6 - 99	27	570	No
Dibenz(a,h)anthracene[b]	**360 - 2,100**	**30**	**379**	**Yes**
Dibenzofuran	360 - 2,100	31	222,174	No
Dibromochloromethane	6 - 16	15	49,504	No
Dieldrin	**17 - 200**	**28**	**187**	**Yes**
Diethylphthalate	360 - 2,100	31	6.41E+07	No
Dimethylphthalate	360 - 2,100	31	8.01E+08	No
Di-n-octylphthalate	360 - 2,100	31	3.21E+06	No
Endosulfan I[b]	8.6 - 99	27	480,861	No
Endosulfan II	17 - 200	28	480,861	No
Endosulfan sulfate	17 - 200	28	480,861	No

129

Table A1.1

Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency less than 5 Percent in Surface Soil/Surface Sediment

Analyte	Range of Reported Results	Total Number of Results	PRG	Maximum Result[a] > PRG?
Endrin	17 - 200	28	24,043	No
Endrin ketone	17 - 200	28	33,326	No
Ethylbenzene	6 - 16	15	5.39E+06	No
Fluorene	360 - 2,100	31	3.21E+06	No
gamma-BHC (Lindane)[b]	8.6 - 99	27	2,771	No
Heptachlor epoxide[b]	8.6 - 99	27	329	No
Heptachlor[b]	8.6 - 99	27	665	No
Hexachlorobenzene	**360 - 2,100**	**31**	**1,870**	**Yes**
Hexachlorobutadiene	360 - 2,100	31	22,217	No
Hexachlorocyclopentadiene	360 - 2,100	30	380,452	No
Hexachloroethane	360 - 2,100	31	111,087	No
Isophorone	360 - 2,100	31	3.16E+06	No
Methoxychlor	86 - 990	28	400,718	No
Naphthalene	360 - 2,100	31	1.40E+06	No
Nitrobenzene	360 - 2,100	31	43,246	No
N-Nitroso-di-n-propylamine	**360 - 2,100**	**31**	**429**	**Yes**
N-nitrosodiphenylamine	360 - 2,100	31	612,250	No
Pentachlorodibenzo-p-dioxin	0.00271	1	N/A	UT
Pentachlorophenol[b]	1,700 - 10,000	30	17,633	No
Phenol[b]	360 - 2,100	30	2.40E+07	No
Prometon	50	1	N/A	UT
Prometryn	50	1	N/A	UT
Propazine	50	1	N/A	UT
Pyridine	1,200 - 1,600	4	N/A	UT
Simazine	50	1	25,000	No
Simetryn	50	1	N/A	UT
Styrene	6 - 16	15	1.38E+07	No
Terbutryn	50	1	N/A	UT
Terbutylazine	50	1	N/A	UT
Tetrachloroethene	6 - 16	15	6,705	No
Toxaphene	170 - 2,000	28	2,720	No
trans-1,3-Dichloropropene	6 - 16	15	20,820	No
Trichloroethene	6 - 16	15	1,770	No
Vinyl acetate	12 - 32	15	2.65E+06	No
Vinyl Chloride	12 - 32	15	2,169	No
Xylene[c]	6 - 16	15	1.06E+06	No

[a] Value is the maximum reported result for nondetected analytes.

[b] Analyte has a detection frequency of less than 5 percent.

[c] The value for total xylene is used.

N/A = Not Available.

UT = Uncertain toxicity.

BOLD = Maximum reported result greater than the PRG.

130

Table A1.2

Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency less than 5 Percent in Subsurface Soil/Subsurface Sediment

Analyte	Range of Reported Results	Total Number of Results	PRG	Maximum Result[a] >PRG?
Inorganic (mg/kg)				
Silver[b]	0.073 - 1.4	51	6,388	No
Organic (µg/kg)				
1,1,1,2-Tetrachloroethane	0.952 - 6	3	1.05E+06	No
1,1,1-Trichloroethane	0.841 - 16	23	1.06E+08	No
1,1,2,2-Tetrachloroethane	0.928 - 16	23	120,551	No
1,1,2-Trichloro-1,2,2-trifluoroethane	0.84 - 6	3	2.74E+10	No
1,1,2-Trichloroethane	1.57 - 16	23	322,253	No
1,1-Dichloroethane	0.782 - 16	23	3.12E+07	No
1,1-Dichloroethene	0.873 - 16	23	199,706	No
1,1-Dichloropropene	0.606 - 6	3	N/A	UT
1,2,3,4,7,8,9-HpCDF	0.00147 - 0.00226	3	N/A	UT
1,2,3,4,7,8-HxCDD	0.00147 - 0.00226	3	5.55	No
1,2,3,6,7,8-HxCDD	0.00147 - 0.00226	3	5.55	No
1,2,3,7,8,9-HxCDD	0.00147 - 0.00226	3	5.55	No
1,2,3,7,8,9-HxCDF	0.00147 - 0.00226	3	N/A	UT
1,2,3-Trichlorobenzene	2.05 - 6	3	N/A	UT
1,2,3-Trichloropropane	1.08 - 6	3	23,910	No
1,2,4-Trichlorobenzene	1.76 - 1,800	13	1.74E+06	No
1,2,4-Trimethylbenzene	1.2 - 6	3	1.53E+06	No
1,2-Dibromo-3-chloropropane	2.21 - 6	3	34,137	No
1,2-Dibromoethane	1.34 - 6	3	403	No
1,2-Dichlorobenzene	1.08 - 1,800	11	3.32E+07	No
1,2-Dichloroethane	1.17 - 16	23	152,603	No
1,2-Dichloroethene	5 - 16	20	1.15E+07	No
1,2-Dichloropropane	0.747 - 16	23	441,907	No
1,3,5-Trimethylbenzene	0.942 - 6	3	1.31E+06	No
1,3-Dichlorobenzene	0.911 - 1,800	13	3.83E+07	No
1,3-Dichloropropane	0.85 - 6	3	N/A	UT
1,4-Dichlorobenzene	1.32 - 1,800	11	1.05E+06	No
2,2-Dichloropropane	0.667 - 6	3	N/A	UT
2,4,5-Trichlorophenol	410 - 8,900	11	9.22E+07	No
2,4,6-Trichlorophenol	340 - 1,800	11	3.13E+06	No
2,4-Dichlorophenol	340 - 1,800	11	2.76E+06	No
2,4-Dimethylphenol	340 - 1,800	11	1.84E+07	No
2,4-Dinitrophenol	1,600 - 8,900	11	1.84E+06	No
2,4-Dinitrotoluene	340 - 1,800	11	1.84E+06	No
2,6-Dinitrotoluene	340 - 1,800	11	921,651	No
2-Butanone	3.89 - 119	15	5.33E+08	No
2-Chloronaphthalene	340 - 1,800	11	7.37E+07	No
2-Chlorophenol	340 - 1,800	11	6.39E+06	No
2-Chlorotoluene	0.68 - 6	3	2.56E+07	No
2-Hexanone	2.2 - 59.5	23	N/A	UT

131

Table A1.2

Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency less than 5 Percent in Subsurface Soil/Subsurface Sediment

Analyte	Range of Reported Results	Total Number of Results	PRG	Maximum Result[a] > PRG?
2-Methylnaphthalene	340 - 1,800	11	3.69E+06	No
2-Methylphenol	340 - 1,800	11	4.61E+07	No
2-Nitroaniline	1,600 - 8,900	11	2.21E+06	No
2-Nitrophenol	340 - 1,800	11	N/A	UT
3,3'-Dichlorobenzidine	670 - 3,700	11	76,667	No
3-Nitroaniline	1,600 - 8,900	10	N/A	UT
4,4'-DDD	33 - 100	7	178,570	No
4,4'-DDE	33 - 100	7	126,049	No
4,4'-DDT	33 - 100	7	125,658	No
4,6-Dinitro-2-methylphenol	1,600 - 8,900	11	92,165	No
4-Bromophenyl-phenylether	340 - 1,800	11	N/A	UT
4-Chloro-3-methylphenol	340 - 2,700	11	N/A	UT
4-Chloroaniline	340 - 2,700	11	3.69E+06	No
4-Chlorophenyl-phenyl ether	340 - 1,800	11	N/A	UT
4-Chlorotoluene	0.891 - 6	3	N/A	UT
4-Isopropyltoluene	0.99 - 6	3	N/A	UT
4-Methyl-2-pentanone	2.78 - 59.5	21	9.57E+08	No
4-Methylphenol	340 - 1,800	11	4.61E+06	No
4-Nitroaniline	1,600 - 8,900	11	2.39E+06	No
4-Nitrophenol	1,600 - 8,900	11	7.37E+06	No
Acenaphthylene	340 - 1,800	11	N/A	UT
Aldrin	17 - 50	7	2,024	No
alpha-BHC	17 - 50	7	6,555	No
alpha-Chlordane	170 - 500	7	117,997	No
Ametryne	50	1	N/A	UT
Aroclor-1016	41 - 500	9	15,514	No
Aroclor-1221	41 - 500	9	15,514	No
Aroclor-1232	41 - 500	9	15,514	No
Aroclor-1242	41 - 500	9	15,514	No
Aroclor-1248	41 - 500	9	15,514	No
Aroclor-1260	41 - 1,000	9	15,514	No
Atraton	50	1	N/A	UT
Atrazine	50 - 410	2	156,820	No
Benzene	0.9 - 16	23	270,977	No
Benzo(b)fluoranthene	340 - 1,800	11	43,616	No
Benzo(g,h,i)perylene	340 - 1,800	11	N/A	UT
Benzo(k)fluoranthene	340 - 1,800	11	436,159	No
Benzyl Alcohol	340 - 2,700	10	2.76E+08	No
beta-BHC	17 - 50	7	22,942	No
beta-Chlordane	330	1	117,997	No
bis(2-Chloroethoxy) methane	340 - 1,800	11	N/A	UT
bis(2-Chloroethyl) ether	340 - 1,800	11	43,315	No
bis(2-Chloroisopropyl) ether	340 - 1,800	10	681,967	No

132

Table A1.2

Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency less than 5 Percent in Subsurface Soil/Subsurface Sediment

Analyte	Range of Reported Results	Total Number of Results	PRG	Maximum Result[a] > PRG?
Bromobenzene	0.954 - 6	3	N/A	UT
Bromochloromethane	1.03 - 6	3	N/A	UT
Bromodichloromethane	1.08 - 16	23	771,304	No
Bromoform	1.18 - 16	23	4.83E+06	No
Bromomethane	4.43 - 32	21	241,033	No
Butylbenzylphthalate	340 - 1,800	11	1.84E+08	No
Carbon Disulfide	0.898 - 16	23	1.88E+07	No
Carbon Tetrachloride	0.823 - 16	23	97,124	No
Chlorobenzene	0.717 - 16	23	7.67E+06	No
Chloroethane	2.23 - 32	23	1.65E+07	No
Chloroform	0.777 - 16	23	90,270	No
Chloromethane	2.51 - 32	23	1.32E+06	No
cis-1,2-Dichloroethene	1.13 - 6	3	1.28E+07	No
cis-1,3-Dichloropropene	1.13 - 16	23	223,462	No
delta-BHC	17 - 50	7	6,555	No
Dibenz(a,h)anthracene	340 - 1,800	10	4,362	No
Dibenzofuran	340 - 1,800	11	2.56E+06	No
Dibromochloromethane	1.17 - 16	23	569,296	No
Dibromomethane	1.12 - 6	3	N/A	UT
Dichlorodifluoromethane	2.76 - 6	3	2.64E+06	No
Dieldrin	33 - 100	7	2,151	No
Diethylphthalate	340 - 1,800	11	7.37E+08	No
Dimethylphthalate	340 - 1,800	11	9.22E+09	No
Di-n-octylphthalate	340 - 1,800	11	3.69E+07	No
Endosulfan I	17 - 50	7	5.53E+06	No
Endosulfan II	33 - 100	7	5.53E+06	No
Endosulfan sulfate	33 - 100	7	5.53E+06	No
Endrin	33 - 100	7	276,495	No
Endrin ketone	33 - 100	7	383,250	No
Ethylbenzene	0.657 - 16	23	6.19E+07	No
Fluorene	340 - 1,800	11	3.69E+07	No
gamma-BHC (Lindane)	17 - 50	7	31,864	No
gamma-Chlordane	170 - 500	6	117,997	No
Heptachlor	17 - 50	7	7,647	No
Heptachlor epoxide	17 - 50	7	3,782	No
Hexachlorobenzene	340 - 1,800	11	21,508	No
Hexachlorobutadiene	1.13 - 1,800	13	255,500	No
Hexachlorocyclopentadiene	340 - 1,800	11	4.38E+06	No
Hexachloroethane	340 - 1,800	11	1.28E+06	No
Isophorone	340 - 1,800	11	3.63E+07	No
Isopropylbenzene	0.516 - 6	3	375,823	No
Methoxychlor	170 - 500	7	4.61E+06	No
n-Butylbenzene	1.34 - 6	3	N/A	UT

133

Table A1.2

Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency less than 5 Percent in Subsurface Soil/Subsurface Sediment

Analyte	Range of Reported Results	Total Number of Results	PRG	Maximum Result[a] > PRG?
Nitrobenzene	340 - 1,800	11	497,333	No
N-Nitroso-di-n-propylamine	340 - 1,800	11	4,929	No
N-nitrosodiphenylamine	340 - 1,800	11	7.04E+06	No
n-Propylbenzene	0.828 - 6	3	N/A	UT
Pentachlorophenol	1,600 - 8,900	11	202,777	No
Phenol	340 - 1,800	11	2.76E+08	No
Prometon	50	1	N/A	UT
Prometryn	50	1	N/A	UT
Propazine	50	1	N/A	UT
Pyrene	340 - 1,800	11	2.55E+07	No
Pyridine	820 - 1,400	2	N/A	UT
sec-Butylbenzene	0.786 - 6	3	N/A	UT
Simazine	50	1	287,502	No
Simetryn	50	1	N/A	UT
Styrene	0.9 - 16	23	1.59E+08	No
Terbutryn	50	1	N/A	UT
Terbutylazine	50	1	N/A	UT
tert-Butylbenzene	1.06 - 6	3	N/A	UT
Toxaphene	330 - 1,000	7	31,284	No
trans-1,2-Dichloroethene	1.09 - 6	3	3.30E+06	No
trans-1,3-Dichloropropene	1.09 - 16	21	239,434	No
Trichloroethene	0.715 - 16	23	20,354	No
Trichlorofluoromethane	0.935 - 6	3	1.74E+07	No
Vinyl acetate	10 - 32	18	3.04E+07	No
Vinyl Chloride	2.45 - 32	23	24,948	No
Xylene[b,c]	3.5 - 16	22	1.22E+07	No

[a] Value is the maximum reported result for nondetected analytes.
[b] Analyte has a detection frequency of less than 5 percent.
[c] The value for total xylene is used.
N/A = Not Available.
UT = Uncertain toxicity.

134

Table A1.3
Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency less than 5 Percent in Surface Soil[a]

Analyte	Range of Reported Results	Total Number of Results	Lowest ESL	Maximum Results[b] > ESL?
Inorganic (mg/kg)				
Uranium	1.40 - 1.80	46	5.00	No
Organic (µg/kg)				
1,2,4-Trichlorobenzene	**360 - 1,100**	**9**	**777**	**Yes**
1,2-Dichlorobenzene	360 - 1,100	9	N/A	UT
1,3-Dichlorobenzene	360 - 1,100	9	N/A	UT
1,4-Dichlorobenzene	360 - 1,100	9	20,000	No
2,4,5-Trichlorophenol	**1,700 - 5,300**	**9**	**4,000**	**Yes**
2,4,6-Trichlorophenol	**360 - 1,100**	**9**	**161**	**Yes**
2,4-Dichlorophenol	360 - 1,100	9	2,744	No
2,4-Dimethylphenol	360 - 1,100	9	N/A	UT
2,4-Dinitrophenol	1,700 - 5,300	9	20,000	No
2,4-Dinitrotoluene	**360 - 1,100**	**9**	**32.1**	**Yes**
2,6-Dinitrotoluene	360 - 1,100	9	6,186	No
2-Chloronaphthalene	360 - 1,100	9	N/A	UT
2-Chlorophenol	**360 - 1,100**	**9**	**281**	**Yes**
2-Methylnaphthalene	360 - 1,100	9	2,769	No
2-Methylphenol	360 - 1,100	9	123,842	No
2-Nitroaniline	1,700 - 5,300	9	5,659	No
2-Nitrophenol	360 - 1,100	9	N/A	UT
3,3'-Dichlorobenzidine	720 - 2,100	9	N/A	UT
3-Nitroaniline	1,700 - 5,300	9	N/A	UT
4,4'-DDD	17.0 - 52.0	9	13,726	No
4,4'-DDE	**17.0 - 52.0**	**9**	**7.95**	**Yes**
4,4'-DDT	**17.0 - 52.0**	**9**	**1.20**	**Yes**
4,6-Dinitro-2-methylphenol	**1,700 - 5,300**	**9**	**560**	**Yes**
4-Bromophenyl-phenylether	360 - 1,100	9	N/A	UT
4-Chloro-3-methylphenol	360 - 1,100	9	N/A	UT
4-Chloroaniline	**360 - 1,100**	**9**	**716**	**Yes**
4-Chlorophenyl-phenyl ether	360 - 1,100	9	N/A	UT
4-Methylphenol	360 - 1,100	9	N/A	UT
4-Nitroaniline	1,700 - 5,300	9	41,050	No
4-Nitrophenol	1,700 - 5,300	9	7,000	No
Acenaphthene	360 - 1,100	9	20,000	No
Acenaphthylene	360 - 1,100	9	N/A	UT
Aldrin	8.60 - 26.0	9	47.0	No
alpha-BHC	8.60 - 26.0	9	18,662	No
alpha-Chlordane	86.0 - 260	9	289	No
Anthracene	360 - 1,100	9	N/A	UT
Aroclor-1016	**86.0 - 260**	**9**	**42.3**	**Yes**
Aroclor-1221	**86.0 - 260**	**9**	**42.3**	**Yes**
Aroclor-1232	**86.0 - 260**	**9**	**42.3**	**Yes**
Aroclor-1242	**86.0 - 260**	**9**	**42.3**	**Yes**
Aroclor-1248	**86.0 - 260**	**9**	**42.3**	**Yes**
Aroclor-1254	**170 - 520**	**9**	**42.3**	**Yes**
Aroclor-1260	**170 - 520**	**9**	**42.3**	**Yes**
Benzo(a)anthracene	360 - 1,100	9	N/A	UT
Benzo(a)pyrene	**360 - 1,100**	**9**	**631**	**Yes**

135

Table A1.3
Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency less than 5 Percent in Surface Soil[a]

Analyte	Range of Reported Results	Total Number of Results	Lowest ESL	Maximum Results[b] > ESL?
Benzo(b)fluoranthene	360 - 1,100	9	N/A	UT
Benzo(g,h,i)perylene	360 - 1,100	9	N/A	UT
Benzo(k)fluoranthene	360 - 1,100	9	N/A	UT
Benzyl Alcohol	360 - 1,100	9	4,403	No
beta-BHC	8.60 - 26.0	9	207	No
beta-Chlordane	86.0 - 100	5	289	No
bis(2-Chloroethoxy) methane	360 - 1,100	9	N/A	UT
bis(2-Chloroethyl) ether	360 - 1,100	9	N/A	UT
bis(2-Chloroisopropyl) ether	360 - 1,100	9	N/A	UT
Butylbenzylphthalate	360 - 1,100	9	24,155	No
delta-BHC	**8.60 - 26.0**	**9**	**25.9**	**Yes**
Dibenz(a,h)anthracene	360 - 1,100	9	N/A	UT
Dibenzofuran	360 - 1,100	9	21,200	No
Dieldrin	**17.0 - 52.0**	**9**	**7.40**	**Yes**
Diethylphthalate	360 - 1,100	9	100,000	No
Dimethylphthalate	360 - 1,100	9	200,000	No
Di-n-butylphthalate	**360 - 1,100**	**9**	**15.9**	**Yes**
Di-n-octylphthalate	360 - 1,100	9	731,367	No
Endosulfan I	8.60 - 26.0	9	80.1	No
Endosulfan II	17.0 - 52.0	9	80.1	No
Endosulfan sulfate	17.0 - 52.0	9	80.1	No
Endrin	**17.0 - 52.0**	**9**	**1.40**	**Yes**
Endrin ketone	**17.0 - 52.0**	**9**	**1.40**	**Yes**
Fluorene	360 - 1,100	9	30,000	No
gamma-BHC (Lindane)	**8.60 - 26.0**	**9**	**25.9**	**Yes**
gamma-Chlordane	160 - 260	4	289	No
Heptachlor	8.60 - 26.0	9	63.3	No
Heptachlor epoxide	8.60 - 26.0	9	64.0	No
Hexachlorobenzene	**360 - 1,100**	**9**	**7.73**	**Yes**
Hexachlorobutadiene	**360 - 1,100**	**9**	**431**	**Yes**
Hexachlorocyclopentadiene	360 - 1,100	9	5,518	No
Hexachloroethane	**360 - 1,100**	**9**	**366**	**Yes**
Indeno(1,2,3-cd)pyrene	360 - 1,100	9	N/A	UT
Isophorone	360 - 1,100	9	N/A	UT
Methoxychlor	86.0 - 260	9	1,226	No
Naphthalene	360 - 1,100	9	27,048	No
Nitrobenzene	360 - 1,100	9	40,000	No
N-Nitroso-di-n-propylamine	360 - 1,100	9	N/A	UT
N-nitrosodiphenylamine	360 - 1,100	9	20,000	No
Pentachlorophenol	**1,700 - 5,300**	**9**	**122**	**Yes**
Phenol	360 - 1,100	9	23,090	No
Toxaphene	170 - 520	9	3,756	No

[a] No analytes detected in less than 5 percent of samples.

[b] Value is the maximum reported result for nondetected analytes.

N/A = Not Available.

UT = Uncertain toxicity.

BOLD = Maximum reported result greater than the ESL.

Table A1.4

Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency less than 5 Percent in Subsurface Soil

Analyte	Range of Reported Results	Total Number of Results	Prairie Dog NOAEL ESL	Maximum Result[a] > ESL?
Inorganic (mg/kg)				
Silver[b]	0.073 - 1.4	44	N/A	UT
Organic (µg/kg)				
1,1,1,2-Tetrachloroethane	5.5 - 6	2	N/A	UT
1,1,1-Trichloroethane	5.5 - 6	20	4.85E+07	No
1,1,2,2-Tetrachloroethane	5.5 - 6	20	4.70E+06	No
1,1,2-Trichloro-1,2,2-trifluoroethane	5.5 - 6	2	N/A	UT
1,1,2-Trichloroethane	5.5 - 6	20	N/A	UT
1,1-Dichloroethane	5.5 - 6	20	215,360	No
1,1-Dichloroethene	5.5 - 6	20	1.28E+06	No
1,1-Dichloropropene	5.5 - 6	2	N/A	UT
1,2,3,4,7,8,9-HpCDF	0.001 - 0.002	2	N/A	UT
1,2,3,4,7,8-HxCDD	0.001 - 0.002	2	N/A	UT
1,2,3,4,7,8-HxCDF	0.001 - 0.002	2	N/A	UT
1,2,3,6,7,8-HxCDD	0.001 - 0.002	2	N/A	UT
1,2,3,6,7,8-HxCDF	0.001 - 0.002	2	N/A	UT
1,2,3,7,8,9-HxCDD	0.001 - 0.002	2	N/A	UT
1,2,3,7,8,9-HxCDF	0.001 - 0.002	2	N/A	UT
1,2,3-Trichlorobenzene	5.5 - 6	2	N/A	UT
1,2,3-Trichloropropane	5.5 - 6	2	1.17E+06	No
1,2,4-Trichlorobenzene	5.5 - 890	8	94,484	No
1,2,4-Trimethylbenzene	5.5 - 6	2	N/A	UT
1,2-Dibromo-3-chloropropane	5.5 - 6	2	N/A	UT
1,2-Dibromoethane	5.5 - 6	2	N/A	UT
1,2-Dichlorobenzene	5.5 - 890	8	N/A	UT
1,2-Dichloroethane	5.5 - 6	20	2.00E+06	No
1,2-Dichloroethene	5.5 - 6	18	1.87E+06	No
1,2-Dichloropropane	5.5 - 6	20	3.92E+06	No
1,3,5-Trimethylbenzene	5.5 - 6	2	855,709	No
1,3-Dichlorobenzene	5.5 - 890	8	N/A	UT
1,3-Dichloropropane	5.5 - 6	2	N/A	UT
1,4-Dichlorobenzene	5.5 - 890	8	5.93E+06	No
2,2-Dichloropropane	5.5 - 6	2	N/A	UT
2,4,5-Trichlorophenol	1,600 - 4,300	6	N/A	UT
2,4,6-Trichlorophenol	340 - 890	6	17,263	No
2,4-Dichlorophenol	340 - 890	6	249,324	No
2,4-Dimethylphenol	340 - 890	6	N/A	UT
2,4-Dinitrophenol	1,600 - 4,300	6	4.90E+06	No
2,4-Dinitrotoluene	340 - 890	6	2,473	No
2,6-Dinitrotoluene	340 - 890	6	477,309	No
2-Butanone	10.0 - 119	14	4.94E+07	No
2-Chloronaphthalene	340 - 890	6	N/A	UT

137

Table A1.4

Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency less than 5 Percent in Subsurface Soil

Analyte	Range of Reported Results	Total Number of Results	Prairie Dog NOAEL ESL	Maximum Result[a] > ESL?
2-Chlorophenol	340 - 890	6	21,598	No
2-Chlorotoluene	5.5 - 6	2	N/A	UT
2-Hexanone	10.0 - 59.5	20	N/A	UT
2-Methylnaphthalene	340 - 890	6	319,121	No
2-Methylphenol	340 - 890	6	9.26E+06	No
2-Nitroaniline	1,600 - 4,300	6	418,475	No
2-Nitrophenol	340 - 890	6	N/A	UT
3,3'-Dichlorobenzidine	670 - 1,800	6	N/A	UT
3-Nitroaniline	1,600 - 3400	5	N/A	UT
4,4'-DDD	33 - 43	4	6.19E+06	No
4,4'-DDE	33 - 43	4	54,420	No
4,4'-DDT	33 - 43	4	175,708	No
4,6-Dinitro-2-methylphenol	1,600 - 4,300	6	44,283	No
4-Bromophenyl-phenylether	340 - 890	6	N/A	UT
4-Chloro-3-methylphenol	340 - 890	6	N/A	UT
4-Chloroaniline	340 - 890	6	48,856	No
4-Chlorophenyl-phenyl ether	340 - 890	6	N/A	UT
4-Chlorotoluene	5.5 - 6	2	N/A	UT
4-Isopropyltoluene	5.5 - 6	2	N/A	UT
4-Methyl-2-pentanone	10.0 - 59.5	18	859,131	No
4-Methylphenol	340 - 890	6	N/A	UT
4-Nitroaniline	1,600 - 4,300	6	2.62E+06	No
4-Nitrophenol	1,600 - 4,300	6	1.02E+06	No
Acenaphthene	340 - 890	6	N/A	UT
Acenaphthylene	340 - 890	6	N/A	UT
Aldrin	17 - 22	4	11,282	No
alpha-BHC	17 - 22	4	2.47E+06	No
alpha-Chlordane	170 - 220	4	472,808	No
Anthracene	340 - 890	6	N/A	UT
Aroclor-1016	170 - 220	4	37,963	No
Aroclor-1221	170 - 220	4	37,963	No
Aroclor-1232	170 - 220	4	37,963	No
Aroclor-1242	170 - 220	4	37,963	No
Aroclor-1248	170 - 220	4	37,963	No
Aroclor-1254	330 - 430	4	37,963	No
Aroclor-1260	330 - 430	4	37,963	No
Benzene	5 - 6	20	1.10E+06	No
Benzo(a)anthracene	340 - 890	6	N/A	UT
Benzo(a)pyrene	340 - 890	6	502,521	No
Benzo(b)fluoranthene	340 - 890	6	N/A	UT
Benzo(g,h,i)perylene	340 - 890	6	N/A	UT
Benzo(k)fluoranthene	340 - 890	6	N/A	UT

138

Table A1.4

Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency less than 5 Percent in Subsurface Soil

Analyte	Range of Reported Results	Total Number of Results	Prairie Dog NOAEL ESL	Maximum Result[a] >ESL?
Benzyl Alcohol	340 - 710	5	253,015	No
beta-BHC	17 - 22	4	27,399	No
bis(2-Chloroethoxy) methane	340 - 890	6	N/A	UT
bis(2-Chloroethyl) ether	340 - 890	6	N/A	UT
bis(2-Chloroisopropyl) ether	340 - 710	5	N/A	UT
bis(2-ethylhexyl)phthalate	340 - 890	6	2.76E+06	No
Bromobenzene	5.5 - 6	2	N/A	UT
Bromochloromethane	5.5 - 6	2	N/A	UT
Bromodichloromethane	5 - 6	20	381,135	No
Bromoform	5 - 6	20	198,571	No
Bromomethane	5.5 - 13	18	N/A	UT
Butylbenzylphthalate	340 - 890	6	3.37E+06	No
Carbon Disulfide	5 - 6	20	410,941	No
Carbon Tetrachloride	5 - 6	20	736,154	No
Chlorobenzene	5 - 6	20	413,812	No
Chloroethane	5.5 - 13	20	N/A	UT
Chloroform	5 - 6	20	560,030	No
Chloromethane	5.5 - 13	20	N/A	UT
Chrysene	340 - 890	6	N/A	UT
cis-1,2-Dichloroethene	5.5 - 6	2	132,702	No
cis-1,3-Dichloropropene	5 - 6	20	222,413	No
delta-BHC	17 - 22	4	3,425	No
Dibenz(a,h)anthracene	340 - 890	6	N/A	UT
Dibenzofuran	340 - 890	6	2.44E+06	No
Dibromochloromethane	5 - 6	20	389,064	No
Dibromomethane	5.5 - 6	2	N/A	UT
Dichlorodifluoromethane	5.5 - 6	2	59,980	No
Dieldrin	33 - 43	4	301	No
Diethylphthalate	340 - 890	6	2.21E+08	No
Dimethylphthalate	340 - 890	6	1.35E+07	No
Di-n-octylphthalate	340 - 890	6	2.58E+08	No
Endosulfan I	17 - 22	4	8,726	No
Endosulfan II	33 - 43	4	8,726	No
Endosulfan sulfate	33 - 43	4	8,726	No
Endrin	33 - 43	4	8,060	No
Endrin ketone	33 - 43	4	8,060	No
Ethylbenzene	5 - 6	20	N/A	UT
Fluoranthene	340 - 890	6	N/A	UT
Fluorene	340 - 890	6	N/A	UT
gamma-BHC (Lindane)	17 - 22	4	3,425	No
gamma-Chlordane	170 - 220	4	472,808	No
Heptachlor	17 - 22	4	12,359	No

Table A1.4

Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency less than 5 Percent in Subsurface Soil

Analyte	Range of Reported Results	Total Number of Results	Prairie Dog NOAEL ESL	Maximum Result[a] > ESL?
Heptachlor epoxide	17 - 22	4	9,121	No
Hexachlorobenzene	340 - 890	6	190,142	No
Hexachlorobutadiene	5.5 - 890	8	150,894	No
Hexachlorocyclopentadiene	340 - 890	6	799,679	No
Hexachloroethane	340 - 890	6	45,656	No
Indeno(1,2,3-cd)pyrene	340 - 710	5	N/A	UT
Isophorone	340 - 890	6	N/A	UT
Isopropylbenzene	5.5 - 6	2	N/A	UT
Methoxychlor	170 - 220	4	228,896	No
Naphthalene	5.5 - 890	8	1.60E+07	No
n-Butylbenzene	5.5 - 6	2	N/A	UT
Nitrobenzene	340 - 890	6	N/A	UT
N-Nitroso-di-n-propylamine	340 - 890	6	N/A	UT
N-nitrosodiphenylamine	340 - 890	6	2.15E+06	No
n-Propylbenzene	5.5 - 6	2	N/A	UT
Pentachlorodibenzo-p-dioxin	0.001 - 0.002	2	N/A	UT
Pentachlorophenol	1,600 - 4,300	6	18,373	No
Phenanthrene	340 - 890	6	N/A	UT
Phenol	340 - 890	6	1.49E+06	No
Pyrene	340 - 890	6	N/A	UT
sec-Butylbenzene	5.5 - 6	2	N/A	UT
Styrene	5 - 6	20	1.53E+06	No
tert-Butylbenzene	5.5 - 6	2	N/A	UT
Toxaphene	330 - 430	4	909,313	No
trans-1,2-Dichloroethene	5.5 - 6	2	1.87E+06	No
trans-1,3-Dichloropropene	5 - 6	18	222,413	No
Trichloroethene	5 - 6	20	32,424	No
Trichlorofluoromethane	5.5 - 6	2	N/A	UT
Vinyl acetate	10 - 13	16	730,903	No
Vinyl Chloride	5.5 - 13	20	6,494	No

[a] Value is the maximum reported result for nondetected analytes.

[b] Analyte has a detection frequency of less than 5 percent.

N/A = Not Available.

UT = Uncertain toxicity.

140

COMPREHENSIVE RISK ASSESSMENT

LOWER WOMAN DRAINAGE EXPOSURE UNIT

VOLUME 11: ATTACHMENT 2

Data Quality Assessment

TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS .... **iv**
EXECUTIVE SUMMARY **ES-1**
1.0 INTRODUCTION **1**
2.0 ANALYTICAL DATA **2**
3.0 FINDINGS **4**
3.1 Dioxins and Furans – Soil 4
3.2 Dioxins and Furans – Water 4
3.3 Herbicides – Soil 5
3.4 Herbicides – Water 5
3.5 Metals – Soil 5
3.6 Metals – Water 5
3.7 Polychlorinated Biphenyls – Soil 5
3.8 Polychlorinated Biphenyls – Water 6
3.9 Pesticides – Soil 6
3.10 Pesticides – Water 6
3.11 Radionuclides – Soil 6
3.12 Radionuclides – Water 7
3.13 Semi-Volatile Organic Compounds – Soil 7
3.14 Semi-Volatile Organic Compounds – Water 7
3.15 Volatile Organic Compounds – Soil 7
3.16 Volatile Organic Compounds – Water 8
3.17 Wet Chemistry Parameters – Soil 8
3.18 Wet Chemistry Parameters – Water 8
4.0 CONCLUSIONS **8**
5.0 REFERENCES **10**

LIST OF TABLES

Table A2.1 CRA Data V&V Summary

Table A2.2 V&V Qualifier Flag Definitions

Table A2.3 V&V Reason Code Definitions

Table A2.4 Standardized V&V Reason Code Definitions, QC Categories, and Affected PARCC Parameters

Table A2.5 Summary of V&V Observations

Table A2.6 Summary of Data Rejected During V&V

Table A2.7 Summary of RPDs/DERs of Field Duplicate Analyte Pairs

Table A2.8 Summary of Data Estimated or Undetected Due to V&V Determinations

142

Table A2.9 Summary of Data Qualified as Undetected Due to Blank Contamination

ACRONYMS AND ABBREVIATIONS

AI	adequate intake
ASD	Analytical Services Division
CRA	Comprehensive Risk Assessment
CRDL	contract required detection limit
DER	duplicate error ratio
DQA	Data Quality Assessment
DQO	data quality objective
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
IDL	instrument detection limit
LCS	laboratory control sample
LWOEU	Lower Woman Drainage Exposure Unit
MDA	minimum detectable activity
MS	matrix spike
MSD	matrix spike duplicate
PARCC	precision, accuracy, representativeness, completeness, and comparability
PCB	polychlorinated biphenyl
QC	quality control
RFETS	Rocky Flats Environmental Technology Site
RI/FS	Remedial Investigation/Feasibility Study
RL	reporting limit
RPD	relative percent difference
SWD	Soil Water Database

V&V	verification and validation
VOC	volatile organic compound

EXECUTIVE SUMMARY

This document provides an assessment of the quality of the data used in the Lower Woman Drainage Exposure Unit (EU) (LWOEU) Comprehensive Risk Assessment (CRA). This Data Quality Assessment (DQA) focuses on all elements of quality control (QC) including both laboratory and sample-specific QC data.

Depending on the matrix and analyte group, anywhere from 39 to 100 percent of the LWOEU data have been verified and/or validated by a validator from the Analytical Services Division (ASD) at the Rocky Flats Environmental Technology Site (RFETS) (or from an outside subcontractor) using verification and validation (V&V) guidelines for each analytical method developed for RFETS. V&V data are identified in the RFETS Soil Water Database (SWD) by a data qualifier flag and reason code(s) that provide an explanation for the qualifier flag. All rejected data have been removed from the data set used in the CRA because the validator has determined the data are unusable. The remaining V&V data have associated qualifier flags indicating that the data are valid, estimated, or undetected, and are used in the CRA. Of the LWOEU V&V data, approximately 16 percent was qualified as estimated and/or undetected. Approximately 4 percent of the data reported as detected by the laboratory were qualified as undetected due to blank contamination. Data qualified as estimated or undetected are a result of various minor laboratory noncompliance issues that are insufficient to render the data unusable.

A review of the LWOEU V&V data indicates that the data meet the data quality objectives (DQOs) outlined in the Final CRA Work Plan and Methodology (K-H 2004), hereafter referred to as the CRA Methodology. A review of the most common observations found in the V&V data determined that a minimal amount, less than 1 percent, of the non-V&V data may have been qualified if a review had been performed. Based on this DQA, data for the LWOEU are of sufficient quality for use in the CRA.

1.0 INTRODUCTION

The Lower Woman Drainage Exposure Unit (EU) (LWOEU) Comprehensive Risk Assessment (CRA) for the Rocky Flats Environmental Technology Site (RFETS) has been prepared in accordance with the Final CRA Work Plan and Methodology (K-H 2005), hereafter referred to as the CRA Methodology. The CRA Methodology was developed jointly with the regulatory agencies using the consultative process and was approved by the agencies on September 28, 2004. Consistent with the CRA Methodology, data quality was assessed using a standard precision, accuracy, representativeness, completeness, and comparability (PARCC) parameter analysis (EPA 2002). Both laboratory and field quality control (QC) were evaluated for the LWOEU data set.

Although many of the elements of QC that are reviewed in this document affect more than one PARCC parameter, their major impact on data quality is described below:

- Precision, as a measure of agreement among replicate measurements, is determined quantitatively based on the results of replicate laboratory measurements. Precision of the laboratory data was verified through review of:
  - Relative percent differences (RPDs) for laboratory control samples (LCSs) and LCS duplicates compared to the acceptable ranges (analytical precision);
  - RPDs (nonradionuclides) and duplicate error ratios (DERs) (radionuclides) for field sample and field duplicates compared to the acceptable ranges[1] (field precision);
  - RPDs for matrix spike (MS) and matrix spike duplicates (MSDs) compared to acceptable control ranges (matrix precision); and
  - RPDs for primary- and second-column analyses (analytical precision).
- Accuracy, as a measure of the distortion of a measurement process that causes error in measuring the true value, is determined quantitatively based on the analysis of samples with a known concentration. Accuracy of the laboratory data was verified through review of:
  - LCS data, calibration verification data, internal standard data, and instrument tune parameters (laboratory accuracy); and

[1] The CRA Methodology states that the overall precision of the data is considered adequate if the RPD between the target and duplicate, at concentrations five times the reporting limit (RL), is less than 35 percent for solids and 20 percent for liquids. The precision adequacy requirement for radiological contaminants is a DER less than 1.96.

  - Surrogate recoveries, MSs, and sample preparation (sample-specific accuracy).

- Representativeness of the data was verified through review of:
  - Laboratory blank data;
  - Sample preservation/storage;
  - Adherence to sample holding times;
  - Documentation issues;
  - Contract noncompliance issues; and
  - Laboratory activities affecting ability to properly identify compounds.

- Completeness is a data adequacy criterion and is addressed in Appendix A, Volume 2 of the Resource Conservation and Recovery Act (RCRA) Facility Investigation-Remedial Investigation/Corrective Measures Study (CMS)-Feasibility Study (RI/FS) Report (hereafter referred to as the RI/FS Report). It refers to the spatial and temporal distribution of the data and their adequacy for estimating exposure point concentrations (EPCs) for the CRA.

- Comparability of the data was verified through evaluation of:
  - Analytical procedures, and whether they were standard U.S. Environmental Protection Agency (EPA)- and RFETS-approved procedures;
  - Instrument types and maintenance, sample preparation techniques, and standard units for reporting; and
  - MS and surrogate samples, ensuring accuracy within acceptable ranges.

2.0 ANALYTICAL DATA

Approximately 52,000 specific analytical records exist in the LWOEU CRA data set, some 75 percent of which (39,030 records) have undergone, verification and validation (V&V). The fraction of the data that was verified and/or validated is shown in Table A2.1 by analyte group and matrix. These data were reviewed by validators and their observations and comments are captured in the Soil Water Database (SWD). All of the data that have been flagged due to V&V findings (except "R"-flagged data) and data that have no flags as a result of V&V are used in the LWOEU CRA. The small amount of data that has not undergone V&V is used as provided by the laboratories. The most common errors found during V&V, such as transcription errors, calculation errors, and excluded records that were later added by the validator, were reviewed to determine the possible effect on non-V&V data. Assuming that the percentage of data qualified as a result of these issues are representative of similar observations in the non-V&V data, less than 1 percent of the entire LWOEU data set is at risk for such unacknowledged and, therefore, uncorrected errors.

Data V&V involves an in-depth review of the data packages from the laboratory to assess compliance with contract requirements. In general, data validation includes all of the activities of verification, as well as additional QC checks and review of some raw laboratory instrument data and calculations. After V&V, a data qualifier flag and/or reason code(s) are assigned to the data record (Tables A2.2 and A2.3). The reason codes provide an explanation for the qualifier flag, thereby making it possible to determine which of the PARCC parameters is affected by the observation (Table A2.4). Qualifier flags are discussed in this Data Quality Assessment (DQA) as those V&V flags that note issues in the data. V&V flags "V," "V1," and "1" represent data that were reviewed by validators, but no issues were observed. Eighty-one percent of the V&V data fall into this category. Additional qualifier flags such as "A," "E," and "Z" were also applied. These validation qualifiers are notations that do not indicate estimation or a change in the status of detection. The data are valid and useable as reported by the laboratory. Three percent of the V&V data are represented by these additional qualifier flags. The specific definitions of these additional V&V flags are presented in Table A2.2. Data with noted issues are presented in Table A2.5 and discussed in detail in Section 3.0.

V&V qualifier flags are not specifically addressed in this data assessment, but rather the reason codes associated with the qualifier flags for each analytical record are summarized and evaluated. This approach was chosen because the validator's specific observations (reason codes), and not the qualifier flags, provide the best descriptors of the data quality.

V&V data records contain a field with V&V reason codes (5, 18/52, 200, 99/101/701, and so forth), or the field is null. These reason codes represent observations related to assessment of precision, accuracy, and representativeness. For example, the reason code 110 definition (see Table A2.3) is "LCS recovery criteria were not met," which is an observation related to data accuracy.

Multiple reason codes were routinely applied to a specific sample method/matrix/analyte combination. Therefore, it was necessary to parse out the individual codes to create a table that included a unique record identifier and the associated parsed data V&V reason code (5, 18, 52, 200, 99, 101, 701, and so forth). With this information and the data V&V reason code definitions, the data validator's observations related to this data set can be re-created for each analytical record.

To summarize the reason codes in a logical manner for presentation, it was first necessary to group the reason codes that have slightly different definitions but that convey the same meaning. A standardized definition was then applied to the individual reason codes within the group. The grouped reason codes were also assigned a QC category (for example, blanks, calibration, and holding time), and the affected PARCC parameter (Table A2.4). The reason codes were then summarized for each medium and analyte group within each QC category, applying the standardized definition to the summarized codes. The summary is presented in Table A2.5.

Rejected data (data qualifier flag "R"), consisting of approximately 4 percent of all V&V data, have been removed from the data used in the LWOEU CRA because the validator has determined the data to be unusable. The fraction of the data that was rejected during validation and/or verification is shown in Table A2.6 by analyte group and matrix.

Finally, evaluating the RPD (DER for radionuclides) between a target sample and the associated field duplicate is not a QC parameter performed during V&V, but is still an important analysis when determining data precision. Because this analysis was not performed during V&V, the target sample/field duplicate RPD and DER calculations were performed separately and are presented in Table A2.7 as the number of exceedances per analyte group/matrix combination. Only those analyte group/matrix combinations having records that met the criteria for calculating an RPD or DER are presented. RPDs and DERs for target sample/field duplicate analyte pairs where one or both of the results are less than five times the RL are not calculated as outlined in the CRA Methodology.

3.0 FINDINGS

V&V observations affecting the CRA data set are summarized by analyte group/matrix/QC category/V&V observation in Table A2.5. The detected and nondetected results are summarized separately to give the reader a better idea of the impact on data usability. Only those issues observed in notable percentages (generally greater than 5 percent) of the data are discussed below in further detail. RPDs (DERs for radionuclides) presented in Table A2.7 are only discussed below when RPD (DER for radionuclides) exceedances of control criteria are greater than 10 percent for any given analyte group/matrix combination. Instances of elevated rates (greater than 10 percent) of rejected data are also discussed below.

3.1 Dioxins and Furans – Soil

Calibration issues resulted in data V&V qualifications related to this analyte group/matrix combination. The percentage of observation is low and within method expectations.

3.2 Dioxins and Furans – Water

Documentation issues resulted in data V&V qualifications related to this analyte group/matrix combination. While the percentage of the data qualified due to transcription errors and validator-added records is high, the data quality is not impacted. All documentation errors of this type have previously been evaluated and corrected.

3.3 Herbicides – Soil

Holding time and other issues resulted in data V&V qualifications related to this analyte group/matrix combination. Although the importance of observing the allowed sample holding time should not be overlooked, it is important to note that the data were qualified as usable, although estimated. The majority of those records qualified as directing the data user to the hard-copy validation report for further explanation of the observation were flagged as estimated. The CRA is performed with this uncertainty in mind; therefore, no other effort was made to identify the observations.

3.4 Herbicides – Water

Calibration, documentation, internal standard, and other issues resulted in data V&V qualifications related to this analyte group/matrix combination. The percentage of qualifications is low with few exceptions. Transcription errors have no impact on data quality as all issues have previously been evaluated and corrected. The majority of those records qualified as directing the data user to the hard-copy validation report for further explanation of the observation were flagged as estimated. The CRA is performed with this uncertainty in mind; therefore, no other effort was made to identify the observations.

3.5 Metals – Soil

Blank, calibration, documentation, holding time, instrument setup, LCS, matrix, sensitivity, and other observations resulted in data V&V qualifications related to this analyte group/matrix combination. The percentage of observations is low, with the exception of those records qualified due to issues with low LCS and MS recoveries and expired instrument detection limit (IDL) studies. While the importance of these QC parameters should not be overlooked, it is also important to note that the data were qualified as usable, although estimated. Although greater than 10 percent of the target sample/field duplicate analyte pairs exceeded RPD criteria, it is important to note that the majority of exceedances were noted in only four sample pairs, this is more indicative of the matrix at a particular location than an overall precision issue.

3.6 Metals – Water

Blank, calculation error, calibration, documentation, holding time, instrument setup, LCS, matrix, sample preparation, sensitivity, and other observations resulted in V&V qualifications associated with this analyte group/matrix combination. The percentage of all observations is low and within method expectations.

3.7 Polychlorinated Biphenyls – Soil

Documentation, holding time, surrogate, and other issues resulted in data V&V observations related to this analyte group/matrix combination. The percentage of observations is low, with the exception of those data qualified due to low surrogate recoveries. While the importance of surrogate analyses should not be overlooked, it is important to note that the data were qualified as usable, although estimated.

3.8 Polychlorinated Biphenyls – Water

Blank, documentation, holding time, surrogate, and other issues resulted in data V&V observations related to this analyte group/matrix combination. The percentage of observations is low, with the exception of those data qualified due to transcription errors and low surrogate recoveries. Transcription errors have no impact on data quality, as all issues have previously been evaluated and corrected. While the importance of surrogate analyses should not be overlooked, it is also important to note that the data were qualified as usable, although estimated.

3.9 Pesticides – Soil

Blank, documentation, holding time, and surrogate issues resulted in data V&V observations related to this analyte group/matrix combination. The percentage of observations is low with the exception of those data qualified due to low surrogate recoveries. While the importance of surrogate analyses should not be overlooked, it is important to note that the data were qualified as usable, although estimated.

3.10 Pesticides – Water

Blank, calibration, confirmation, documentation, holding time, internal standard, surrogate, and other issues resulted in V&V qualification related to this analyte group/matrix combination. The percentage of observations is low, with the exception of those data qualified due to transcription errors and low surrogate recoveries. Transcription errors have no impact on data quality, as all issues have previously been evaluated and corrected. While the importance of surrogate analyses should not be overlooked, it is also important to note that the data were qualified as usable, although estimated.

3.11 Radionuclides – Soil

Blank, calculation error, calibration, documentation, holding time, instrument setup, LCS, matrix, sensitivity, and other observations resulted in V&V qualifications related to this analyte group/matrix combination. The percentage of observations is low with few exceptions. Insufficient documentation indicates that a complete V&V evaluation may not have been performed, but it is important to note that the data were qualified as usable, although estimated. Transcription errors and validator-calculated minimum detectable activities (MDAs) have no effect on data quality, as all issues have previously been evaluated and corrected. While the importance of QC parameters such as blank, LCS, and MS analyses should not be overlooked, it is also important to note that all data used in this CRA were qualified as usable, although estimated. Although 16 percent of the V&V data for this analyte group/matrix combination was rejected, 94 percent of all associated data underwent V&V. This leaves less than 1 percent of the data related to this analyte group/matrix combination that may have been rejected if a review had been performed. Finally, although approximately 14 percent of the target sample/field duplicate analyte pairs exceeded RPD criteria, it is important to note that the majority of exceedances were noted in only two sample pairs, this is more indicative of a matrix at a particular location than an overall precision indication.

3.12 Radionuclides – Water

Blank, calculation error, calibration, documentation, holding time, instrument setup, LCS, matrix, sample preparation, sensitivity, and other observations resulted in V&V qualifications related to this analyte group/matrix combination. The percentage of observations is low with the exception of those records qualified because they were added by the reviewer. Validator-added records have no impact on data usability, as all issues have previously been evaluated and corrected. Approximately 14 percent of the V&V data for this analyte group/matrix combination were rejected. Taking into account that only 40 percent of the CRA data associated with this analyte group and matrix was either validated and/or verified, as much as 8 percent of the data used in the CRA may have been rejected if a review had been performed.

3.13 Semi-Volatile Organic Compounds – Soil

Blank, calibration, documentation, holding time, internal standard, matrix, and other observations resulted in V&V qualifications related to this analyte group/matrix combination. The percentage of observations is low with few exceptions. While the importance of observing the allowed sample holding time should not be overlooked, the data were not qualified as grossly exceeding the holding time, as would be the case where appropriate. Instead, the data were qualified as usable, although estimated. The majority of those records qualified as directing the data user to the hard-copy validation report for further explanation of the observation were flagged as estimated. The CRA is performed with this uncertainty in mind; therefore, no other effort was made to identify the observations.

3.14 Semi-Volatile Organic Compounds – Water

Blank, calibration, documentation, holding time, instrument setup, internal standard, LCS, matrix, and other issues resulted in V&V observations related to this analyte group/matrix combination. The percentage of all observations is low and within method expectations.

3.15 Volatile Organic Compounds – Soil

Blank, calculation error, calibration, documentation, holding time, internal standard, matrix, and other issues resulted in V&V observations related to this analyte

148

group/matrix combination. The percentage of all observations is low and within method expectations.

3.16 Volatile Organic Compounds – Water

Blank, calibration, documentation, holding time, instrument setup, internal standard, LCS, matrix, surrogate, and other issues resulted in V&V observations related to this analyte group/matrix combination. The percentage of observations is low with few exceptions. The omissions or errors noted in the data package do not impact data quality, as the omitted data were not required for V&V. While the importance of observing allowed sample holding times and proper instrument setup should not be overlooked, it is important to note that the data were qualified as usable, although estimated.

3.17 Wet Chemistry Parameters – Soil

Blank, documentation, holding time, matrix, and other issues resulted in V&V observations related to this analyte group/matrix combination. While the percentage of several of the observations is high, it is important to note that this analyte group contains numerous general chemistry parameters having little or no impact on site characterization.

3.18 Wet Chemistry Parameters – Water

Blank, calculation error, calibration, documentation, holding time, matrix, sample preparation, and other issues resulted in V&V observations related to this analyte group/matrix combination. The percentage of all observations is low and within method expectations.

4.0 CONCLUSIONS

The quality of the laboratory results were evaluated for compliance with the CRA Methodology data quality objectives (DQOs) through an overall review of PARCC parameters.

Of the data used in the LWOEU CRA, approximately 75 percent underwent the V&V process. Of that 75 percent, 81 percent was qualified as having no QC issues, and approximately 16 percent was qualified as estimated or undetected (Table A2.8). The remaining 3 percent of the V&V data is made up of records qualified with additional flags indicating acceptable data such as "A," "E," or "P." Approximately 4 percent of the data reported as detected by the laboratory were flagged as undetected by the validators due to blank contamination (Table A2.9). Data qualified as estimated or undetected indicate some issues with PARCC parameters, but not to a degree sufficient to mark the data unusable. Approximately 4 percent of the entire data set was rejected during the V&V process (Table A2.6).

Although many of the elements of QC that are reviewed in this document affect more than one PARCC parameter, the general discussion below summarizes the data quality per the validation reason codes affecting each specific PARCC parameter. Several V&V reason codes have no real impact on data quality because they represent issues that were noted but corrected, or represent observations related to missing documentation that was not required for data assessment. Approximately 17 percent of the LWOEU V&V data were flagged with these "Other" V&V observations.

- Precision, as a measure of agreement among replicate measurements, is determined quantitatively based on the results of replicate laboratory measurements.

  Of the V&V data, approximately 2 percent was noted for observations related to precision. Of that 2 percent, 99 percent was qualified for issues related to sample matrices. Result confirmation and instrument setup observations make up the other 1 percent. No LCS or instrument sensitivity issues related to precision were noted.

  RPDs and DERs for target sample/field duplicate pairs were found to be acceptable for all analyte group/matrix combinations. Overall, the method precision was found to be generally acceptable.

- Accuracy is a measure of the distortion of a measurement process that causes error in the true value.

  Of the V&V data, 37 percent was noted for accuracy-related observations. Of that 37 percent, 75 percent was noted for laboratory practice-related observations, while sample-specific accuracy observations make up the other 25 percent. Although the percentage of data with noted accuracy issues is slightly elevated, it is important to note that most of the data flagged with these accuracy-related observations are also flagged as estimated, and the CRA is performed with this uncertainty in mind.

  Accuracy was generally acceptable with infrequent performance outside QC limits.

- Representativeness of the data was verified.

  Of the V&V data, approximately 36 percent was noted for observations related to representativeness. Of that 36 percent, 67 percent was qualified for blank observations, 25 percent for failure to observe allowed holding times, 3 percent for documentation issues, and approximately 1 percent each for sample preparation and sensitivity observations. Instrument setup, LCS, matrix, and other observations make up the other 3 percent of the data qualified for observations related to sample representativeness.

  Reportable levels of target analytes were not routinely detected in the laboratory blanks greater than the laboratory RLs except for relatively isolated incidences.

Samples were generally stored and preserved properly. Overall, these elements of QC exceedances are indicative of normal laboratory operations and have little impact on the sample data as reported.

Sample data are representative of the site conditions at the time of sample collection.

- Comparability of the data was reviewed and no systematic errors were noted.

  - The use of standard EPA- and RFETS-approved analytical procedures;

  - Instrument types and maintenance, sample preparation techniques, and standard units for reporting; and

  - Evaluation of MS and surrogate samples, ensuring accuracy within acceptable ranges.

  Examination of these parameters did not show any systematic issues with comparability.

- Completeness, as defined in the CRA Methodology, is addressed in Appendix A, Volume 2 of the RI/FS Report.

  Another indication of completeness that is sometimes used is a measure of the number of valid measurements obtained in relation to the total number of measurements planned.

  Because less than 5 percent of the overall data were rejected, the use of non-V&V data for the LWOEU CRA does not contribute to any completeness issues.

This review concludes that the PARCC of the data are generally acceptable and the CRA objectives have been met.

5.0 REFERENCES

EPA, 2002. Guidance for Quality Assurance Project Plans. EPA QA/G-5, EPA/240/R-02/009. Office of Environmental Information, Washington, D.C. December.

K-H, 2005. Final Comprehensive Risk Assessment Work Plan and Methodology, Environmental Restoration, Rocky Flats Environmental Technology Site, Golden, Colorado. Revision 1. September.

TABLES

Table A2.1
CRA Data V&V Summary

Analyte Group	Matrix	Total No. of V&V Records	Total No. of CRA Records	Percent V&V (%)
Dioxins and Furans	SOIL	68	68	100.00
Dioxins and Furans	WATER	14	14	100.00
Herbicide	SOIL	42	44	95.45
Herbicide	WATER	93	241	38.59
Metal	SOIL	4,573	4,578	99.89
Metal	WATER	10,408	12,549	82.94
PCB	SOIL	238	287	82.93
PCB	WATER	245	371	66.04
Pesticide	SOIL	680	760	89.47
Pesticide	WATER	799	1,497	53.37
Radionuclide	SOIL	771	820	94.02
Radionuclide	WATER	3,016	7,621	39.57
SVOC	SOIL	2,472	2,476	99.84
SVOC	WATER	2,696	4,227	63.78
VOC	SOIL	1,443	1,511	95.50
VOC	WATER	10,280	13,204	77.86
Wet Chemistry	SOIL	121	121	100.00
Wet Chemistry	WATER	1,071	1,615	66.32
	Total	**39,030**	**52,004**	**75.05%**

Table A2.2
V&V Qualifier Flag Definitions

Validation Qualifier Code	Description
1	QC data from a data package – Verification
A	Data acceptable with qualifications
B	Compound was found in BLK and sample
C	Calibration
E	Associated value exceeds calibration range; dilute and reanalyze
J	Estimated quantity – Validation
J1	Estimated quantity – Verification
JB	Organic method blank contamination – Validation
JB1	Organic method blank contamination – Verification
N	Historical – Validators asked not to validate this
NJ	Associated value is presumptively estimated
NJ1	Value presumptively estimated – Verification
P	Systematic error
R	Data unusable – Validation
R1	Data unusable – Verification
S	Matrix spike
U	Analyzed, not detected at/above method detection limit
U1	Analyzed, not detect at/above method detection limit – Verification
UJ	Associated value is considered estimated at an elevated detection
UJ1	Estimated at elevated level – Verification
V	No problems with the data – Validation
V1	No problems with the data – Verification
Y	Analytical results in validation process
Z	Validation was not requested or could not be performed

152

Table A2.3
V&V Reason Code Definitions

Validation Reason Code	Description
***	Unknown code from RFEDS
1	Holding times were exceeded
2	Holding times were grossly exceeded
3	Initial calibration correlation coefficient <0.995
4	Calibration verification criteria were not met
5	CRDL check sample recovery criteria were not met
6	Incorrect calibration of instrument
7	Analyte values > IDL were found in the blanks
8	Negative bias was indicated in the blanks
9	Interference indicated in the ICP interference check sample
10	Laboratory control sample recovery criteria were not met
11	Duplicate sample precision criteria were not met
12	Predigestion matrix spike criteria were not met (+/- 25 percent)
13	Predigestion matrix spike criteria were not met (<30 percent)
14	Post-digestion matrix spike recovery criteria were not met
15	MSA was required but not performed
16	MSA calibration correlation coefficient <0.995
17	Serial dilution criteria not met
18	Documentation was not provided
19	Calibration verification criteria not met
20	AA duplicate injection precision criteria were not met
21	Reagent blanks exceeded MDA
22	Tracer contamination
23	Improper aliquot size
24	Sample aliquot not taken quantitatively
25	Primary standard had exceeded expiration date
26	No raw data submitted by the laboratory
27	Recovery criteria were not met
28	Duplicate analysis was not performed
29	Verification criteria were not met
30	Replicate precision criteria were not met
31	Replicate analysis was not performed
32	Laboratory control samples >+/- 3 sigma
33	Laboratory control samples >+/- 2 sigma and <+/- 3 sigma
35	Transformed spectral index external ST criteria were not met
36	MDA exceeded the RDL
37	Sample exceeded efficiency curve weight limit
38	Excessive solids on planchet
39	Tune criteria not met
40	Organics initial calibration criteria were not met
41	Organics continuing calibration criteria were not met
42	Surrogates were outside criteria
43	Internal standards outside criteria
44	No mass spectra were provided
45	Results were not confirmed
47	Percent breakdown exceeded 20 percent
48	Linear range of instrument was exceeded

153

Table A2.3
V&V Reason Code Definitions

Validation Reason Code	Description
49	Method blank contamination
51	Nonverifiable laboratory results and/or unsubmitted data
52	Transcription error
53	Calculation error
54	Incorrect reported activity or MDA
55	Result exceeds linear range; serial dilution value reported
56	IDL changed due to significant figure discrepancy
57	Percent solids < 30 percent
58	Percent solids < 10 percent
59	Blank activity exceeded RDL
60	Blank recovery criteria were not met
61	Replicate recovery criteria were not met
62	LCS relative percent error criteria not met
63	LCS expected value not submitted/verifiable
64	Nontraceable/noncertified standard was used
67	Sample results not submitted/verifiable
68	Frequency of quality control samples not met
69	Samples not distilled
70	Resolution criteria not met
71	Unit conversion of results
72	Calibration counting statistics not met
73	Daily instrument performance assessment not performed
74	LCS data not submitted
75	Blank data not submitted
76	Instrument gain and/or efficiency not submitted
77	Detector efficiency criteria not met
78	MDAs were calculated by reviewer
79	Result obtained through dilution
80	Spurious counts of unknown origin
81	Repeat count outside of 3 sigma counting error
82	Sample results were not corrected for decay
83	Sample results were not included on Data Summary Table
84	Key fields wrong
85	Record added by QLI
86	Results considered qualitative not quantitative
87	Laboratory did no analysis for this record
88	Blank corrected results
89	Sample analysis was not requested
90	Sample result was not validated due to reanalysis
91	Unit conversion; QC sample activity/uncertainty/MDA
99	See hard copy for further explanation
101	Holding times were exceeded (attributed to laboratory problem)
102	Holding times were grossly exceeded (attribute to laboratory problem)
103	Calibration correlation coefficient does not meet requirement
104	Calibration verification recovery criteria were not met
105	Low-level check sample recovery criteria were not met
106	Calibration did not contain minimum number of standards

Table A2.3
V&V Reason Code Definitions

Validation Reason Code	Description
107	Analyte detected but < RDL in calibration blank verification
109	Interference indicated in the ICP interference check sample
110	Laboratory control sample recovery criteria were not met
111	Laboratory duplicate sample precision criteria were not met
112	Predigestion matrix spike criteria were not met (+/- 25 percent)
113	Predigestion matrix spike recovery is <30 percent
114	Post-digestion matrix spike criteria were not met
115	MSA was required but not performed
116	MSA calibration correlation coefficient <0.995
117	Serial dilution percent D criteria not met
123	Improper aliquot size
128	Laboratory duplicate was not analyzed
129	Verification criteria for frequency or sequence were not met
130	Replicate precision criteria were not met
131	Confirmation percent difference criteria not met
132	Laboratory control samples >+/- 3 sigma
136	MDA exceeded the RDL
139	Tune criteria not met
140	Requirements for independent calibration verification were not met
141	Continuing calibration verification criteria were not met
142	Surrogates were outside criteria
143	Internal standards outside criteria
145	Results were not confirmed
147	Percent breakdown exceeded 20 percent
148	Linear range of measurement system was exceeded
149	Method, preparation, or reagent blank contamination > RDL
150	Unknown carrier volume
152	Reported data do not agree with raw data
153	Calculation error
155	Original result exceeds linear range; serial dilution value reported
159	Magnitude of calibration verification blank result exceeded the RDL
164	Standard traceability or certification requirements not met
166	Carrier aliquot nonverifiable
168	QC sample frequency does not meet requirements
170	Resolution criteria not met
172	Calibration counting statistics not met
174	LCS data not submitted
175	Blank data not submitted
177	Detector efficiency criteria not met
188	Blank corrected results
199	See hard copy for further explanation
201	Preservation requirements not met by the laboratory
205	Unobtainable omissions or errors on SDP (required for databases)
206	Analyses were not requested according to the SOW
207	Sample pretreatment or sample preparation method is incorrect
211	Poor cleanup recovery
212	Instrument detection limit was not provided

Table A2.3
V&V Reason Code Definitions

Validation Reason Code	Description
213	Instrument detection limit is > the associated RDL
214	IDL is older than 3 months from date of analysis
215	Blank results were not reported to the IDL/MDL
216	Post-digestion spike recoveries outside of 85-115 percent criteria
217	Post-digestion spike recoveries were < 10 percent
218	Sample COC was not verifiable (attributed to laboratory)
219	Standards have expired or are not valid
220	TCLP sample percent solids < 0.5 percent
222	TCLP particle size was not performed
224	Incomplete TCLP extraction data
225	Insufficient TCLP extraction time
226	TIC misidentification
227	No documentation regarding deviations from methods or SOW
228	Calibration recoveries affecting data quality have not been met
229	Element not analyzed in ICP interference check sample
230	QC sample/analyte (e.g., spike, duplicate, LCS) not analyzed
231	MS/MSD criteria not met
232	Control limits not assigned correctly
233	Sample matrix QC does not represent samples analyzed
234	QC sample does not meet method requirement
235	Duplicate sample control limits do not pass
236	LCS control limits do not pass
237	Preparation blank control limits do not pass
238	Blank correction was not performed
239	Winsorized mean plus standard deviation of the same not calculated or calculated wrong
240	Sample preparations for soil/sludge/sediment were not homog/aliq properly
241	No micro PPT or electroplating data available
242	Tracer requirements were not met
243	Standard values were not calculated correctly (LCS, tracer, standards)
244	Standard or tracer is not NIST traceable
245	Energy calibration criteria not met
246	Background calibration criteria were not met
247	Sample or control analysis not chemically separated from each other
248	Single combined TCLP result was not repeated for sample with both mis+nonm
249	Result qualified due to blank contamination
250	Incorrect analysis sequence
251	Misidentified target compounds
252	Result is suspect DU
701	Holding times were exceeded (not attributed to laboratory)
702	Holding times were grossly exceeded (not attributed to laboratory)
703	Samples were not preserved properly in the field (not attributed to laboratory)
801	Missing deliverables (required for data assessment)
802	Missing deliverables (not required for data assessment)
803	Omissions or errors on SDP deliverables (required for data assessment)
804	Omissions or errors on SDP deliverables (not required for data assessment
805	Information missing from case narrative
806	Site samples not used for sample matrix QC
807	Original documentation not provided

156

Table A2.3
V&V Reason Code Definitions

Validation Reason Code	Description
808	Incorrect or incomplete DRC
809	Non-site samples reported with site samples
810	EDD does not match hard copy; EDD may be resubmitted

Table A2.4

Standardized V&V Reason Code Definitions, QC Categories, and Affected PARCC Parameters

Validation Reason Codes	Standardized Description	QC Category	Affected PARCC Parameter
188, 88	Blank corrected results	Blanks	Representativeness
238	Blank correction was not performed	Blanks	Representativeness
175, 75	Blank data not submitted	Blanks	Representativeness
60	Blank recovery criteria were not met	Blanks	Representativeness
215	Blank results were not reported to the IDL/MDL	Blanks	Representativeness
107, 159	Calibration verification blank contamination	Blanks	Representativeness
149, 21, 237, 249, 49, 59, 7	Method, preparation, or reagent blank contamination	Blanks	Representativeness
8	Negative bias indicated in the blanks	Blanks	Representativeness
153, 53	Calculation error	Calculation Errors	Other
232	Control limits not assigned correctly	Calculation Errors	Other
246	Background calibration criteria were not met	Calibration	Accuracy
103, 3	Calibration correlation coefficient did not meet requirements	Calibration	Accuracy
172, 72	Calibration counting statistics did not meet criteria	Calibration	Accuracy
106	Calibration did not contain minimum number of standards	Calibration	Accuracy
228	Calibration requirements affecting data quality have not been met	Calibration	Accuracy
104, 141, 19, 29, 4, 40, 41	Continuing calibration verification criteria were not met	Calibration	Accuracy
245	Energy calibration criteria not met	Calibration	Accuracy
6	Incorrect calibration of instrument	Calibration	Accuracy
148, 48	Result exceeded linear range of measurement system	Calibration	Accuracy
155, 55	Original result exceeded linear range, serial dilution value reported	Calibration	Accuracy
140	Requirements for independent calibration verification were not met	Calibration	Accuracy
129	Frequency or sequencing verification criteria not met	Calibration	Accuracy
131	Confirmation percent difference criteria not met	Confirmation	Precision
145, 45	Results were not confirmed	Confirmation	Precision
18	Sufficient documentation not provided by the laboratory	Documentation issues	Representativeness
705	Electronic qualifiers were applied from validation report by hand	Documentation issues	Other
805	Information missing from case narrative	Documentation issues	Other
84	Key data field incorrect	Documentation issues	Other
802	Missing deliverables (not required for validation)	Documentation issues	Other
801	Missing deliverables (required for validation)	Documentation issues	Representativeness
227	No documentation regarding deviations from methods or SOW	Documentation issues	Other
44	No mass spectra were provided	Documentation issues	Representativeness
241	No micro pipette or electroplating data available	Documentation issues	Other
26	No raw data submitted by the laboratory	Documentation issues	Representativeness
804	Omissions or errors in SDP (not required for validation)	Documentation issues	Other
803	Omissions or errors in SDP (required for validation)	Documentation issues	Representativeness
807	Original documentation not provided	Documentation issues	Other

158

Table A2.4
Standardized V&V Reason Code Definitions, QC Categories, and Affected PARCC Parameters

Validation Reason Codes	Standardized Description	QC Category	Affected PARCC Parameter
85	Record added by the validator	Documentation issues	Other
152	Reported data do not agree with raw data	Documentation issues	Other
89	Sample analysis was not requested	Documentation issues	Other
218	Sample COC was not verifiable (attributed to laboratory)	Documentation issues	Representativeness
704	Sample COC was not verifiable (not attributed to laboratory)	Documentation issues	Representativeness
83	Sample results were not included on Data Summary Table	Documentation issues	Other
52	Transcription error	Documentation issues	Other
205	Unobtainable omissions or errors on SDP (required for data assessment)	Documentation issues	Representativeness
1, 101, 701	Holding times were exceeded	Holding times	Representativeness
2, 102, 702	Holding times were grossly exceeded	Holding times	Representativeness
251	Misidentified target compounds	Identification errors	Representativeness
70	Resolution criteria not met	Identification errors	Representativeness
226	TIC misidentification	Identification errors	Representativeness
143, 43	Internal standards did not meet criteria	Internal standards	Accuracy
5	CRDL check sample recovery criteria were not met	LCS	Accuracy
33	LCS > ± 2 sigma and < ± 3 sigma	LCS	Accuracy
10, 110, 236	LCS recovery criteria were not met	LCS	Accuracy
132, 32	Laboratory control samples > ± 3 sigma	LCS	Accuracy
174, 74	LCS data not submitted	LCS	Representativeness
63	Expected LCS value not submitted/verifiable	LCS	Representativeness
62	LCS relative percent error criteria not met	LCS	Accuracy
105	Low-level check sample recovery criteria were not met	LCS	Accuracy
230	QC sample/analyte (e.g., spike, duplicate, LCS) not analyzed	LCS	Representativeness
28	Duplicate analysis was not performed	Matrices	Precision
11, 235	Duplicate sample precision criteria were not met	Matrices	Precision
111	LCS/LCSD precision criteria were not met	Matrices	Precision
128	Laboratory duplicate was not analyzed	Matrices	Precision
231	MS/MSD criteria not met	Matrices	Precision
116, 16	MSA calibration correlation coefficient <0.995	Matrices	Accuracy
115, 15	MSA was required but not performed	Matrices	Representativeness
58	Sample contained < 10 percent solid material	Matrices	Representativeness
57	Sample contained < 30 percent solid material	Matrices	Representativeness
217	Post-digestion spike recoveries were < 10%	Matrices	Accuracy
14, 114, 216	Post-digestion matrix spike criteria were not met	Matrices	Accuracy
113, 13	Predigestion matrix spike recovery is <30%	Matrices	Accuracy
112, 12	Predigestion matrix spike recovery criteria were not met	Matrices	Accuracy
27	Recovery criteria were not met	Matrices	Accuracy
31	Replicate analysis was not performed	Matrices	Precision
130, 30	Replicate precision criteria were not met	Matrices	Precision
61	Replicate recovery criteria were not met	Matrices	Accuracy
233	Sample matrix QC does not represent samples analyzed	Matrices	Representativeness
117, 17	Serial dilution criteria not met	Matrices	Accuracy

159

Table A2.4
Standardized V&V Reason Code Definitions, QC Categories, and Affected PARCC Parameters

Validation Reason Codes	Standardized Description	QC Category	Affected PARCC Parameter
806	Site samples not used for sample matrix QC	Matrices	Representativeness
810	EDD does not match hard copy; EDD may be resubmitted	Other	Other
214	IDL is older than 3 months from date of analysis	Other	Accuracy
250	Incorrect analysis sequence	Other	Representativeness
808	Incorrect or incomplete DRC	Other	Representativeness
212	Instrument detection limit was not provided	Other	Other
87	Laboratory did no analysis for this record	Other	Other
809	Nonsite samples reported with Site samples	Other	Other
64	Nontraceable/noncertified standard was used	Other	Accuracy
51	Nonverifiable laboratory results and/or unsubmitted data	Other	Representativeness
211	Poor cleanup recovery	Other	Accuracy
25	Primary standard had exceeded expiration date	Other	Accuracy
234	QC sample does not meet method requirement	Other	Representativeness
168, 68	QC sample frequency does not meet requirements	Other	Representativeness
252	Result is suspect due to dilution	Other	Other
79	Result obtained through dilution	Other	Other
37	Sample exceeded efficiency curve weight limit	Other	Accuracy
247	Sample or control analyses not chemically separated from each other	Other	Representativeness
90	Sample result was not validated due to re-analysis	Other	Other
67	Sample results not submitted/verifiable	Other	Representativeness
199, 99	See hard copy for further explanation	Other	Other
248	Single combined TCLP results was not reported for sample with both mis+nonm	Other	Accuracy
80	Spurious counts of unknown origin	Other	Representativeness
244	Standard or tracer is not NIST traceable	Other	Accuracy
164	Standard traceability or certification requirements not met	Other	Accuracy
219	Standards have expired or are not valid	Other	Accuracy
243	Standard values were not calculated correctly (LCS, tracer, standards)	Other	Other
22	Tracer contamination	Other	Accuracy
242	Tracer requirements were not met	Other	Accuracy
71	Unit conversion of results	Other	Other
239	Winsorized mean+standard deviation of the same not calculated or calculated wrong	Other	Other
38	Excessive solids on planchet	Sample preparation	Accuracy
123, 23	Improper aliquot size	Sample preparation	Accuracy
224	Incomplete TCLP extraction data	Sample preparation	Representativeness
225	Insufficient TCLP extraction time	Sample preparation	Representativeness
201	Preservation requirements not met by the laboratory	Sample preparation	Representativeness
24	Sample aliquot not taken quantitatively	Sample preparation	Accuracy
240	Sample preparation for soil/sludge/ sediment were not homog/aliq properly	Sample preparation	Representativeness
207	Sample pretreatment or preparation method is incorrect	Sample preparation	Representativeness
69	Samples not distilled	Sample preparation	Representativeness
703	Samples were not preserved properly in the field	Sample preparation	Representativeness

160

Table A2.4
Standardized V&V Reason Code Definitions, QC Categories, and Affected PARCC Parameters

Validation Reason Codes	Standardized Description	QC Category	Affected PARCC Parameter
222	TCLP particle size was not performed	Sample preparation	Representativeness
220	TCLP sample percent solids < 0.5 percent	Sample preparation	Representativeness
56	IDL changed due to significant figure discrepancy	Sensitivity	Representativeness
54	Incorrect reported activity or MDA	Sensitivity	Other
213	Instrument detection limit > the associated RDL	Sensitivity	Representativeness
136, 36	MDA exceeded the RDL	Sensitivity	Representativeness
78	MDA was calculated by reviewer	Sensitivity	Other
81	Repeat count outside of 3 sigma counting error	Sensitivity	Precision
86	Results considered qualitative not quantitative	Sensitivity	Accuracy
82	Sample results were not corrected for decay	Sensitivity	Other
91	Unit conversion, QC sample activity uncertainty/MDA	Sensitivity	Representativeness
142, 42	Surrogates were outside criteria	Surrogate	Accuracy
20	AA duplicate injection precision criteria were not met	Instrument Set-up	Precision
73	Daily instrument performance assessment not performed	Instrument Set-up	Accuracy
177, 77	Detector efficiency criteria not met	Instrument Set-up	Accuracy
229	Element not analyzed in ICP interference check sample	Instrument Set-up	Representativeness
76	Instrument gain and/or efficiency not submitted	Instrument Set-up	Representativeness
109, 9	Interference indicated in the ICP interference check sample	Instrument Set-up	Accuracy
147, 47	Percent breakdown exceeded 20 percent	Instrument Set-up	Representativeness
170	Resolution criteria not met	Instrument Set-up	Representativeness
35	Transformed spectral index external site criteria were not met	Instrument Set-up	Representativeness
139, 39	Tune criteria not met	Instrument Set-up	Accuracy
206	Analysis was not requested according to SOW	Unknown	Other
166	Carrier aliquot nonverifiable	Unknown	Representativeness
150	Unknown carrier volume	Unknown	Representativeness

161

Table A2.5
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
Dioxins and Furans	SOIL	Calibration	Continuing calibration verification criteria were not met	Yes	1	68	1.47
Dioxins and Furans	WATER	Documentation Issues	Record added by the validator	No	2	14	14.29
Dioxins and Furans	WATER	Documentation Issues	Transcription error	No	3	14	21.43
Herbicide	SOIL	Holding Times	Holding times were exceeded	No	3	42	7.14
Herbicide	SOIL	Other	See hard copy for further explanation	No	3	42	7.14
Herbicide	WATER	Calibration	Continuing calibration verification criteria were not met	No	1	93	1.08
Herbicide	WATER	Documentation Issues	Record added by the validator	No	1	93	1.08
Herbicide	WATER	Documentation Issues	Transcription error	No	21	93	22.58
Herbicide	WATER	Internal Standards	Internal standards did not meet criteria	No	1	93	1.08
Herbicide	WATER	Other	See hard copy for further explanation	No	32	93	34.41
Metal	SOIL	Blanks	Calibration verification blank contamination	No	117	4,573	2.56
Metal	SOIL	Blanks	Calibration verification blank contamination	Yes	19	4,573	0.42
Metal	SOIL	Blanks	Method, preparation, or reagent blank contamination	No	65	4,573	1.42
Metal	SOIL	Blanks	Method, preparation, or reagent blank contamination	Yes	12	4,573	0.26
Metal	SOIL	Blanks	Negative bias indicated in the blanks	No	13	4,573	0.28
Metal	SOIL	Blanks	Negative bias indicated in the blanks	Yes	26	4,573	0.57
Metal	SOIL	Calibration	Calibration correlation coefficient did not meet requirements	Yes	6	4,573	0.13
Metal	SOIL	Calibration	Continuing calibration verification criteria were not met	No	6	4,573	0.13
Metal	SOIL	Calibration	Continuing calibration verification criteria were not met	Yes	6	4,573	0.13
Metal	SOIL	Documentation Issues	Key data fields incorrect	Yes	2	4,573	0.04
Metal	SOIL	Documentation Issues	Transcription error	No	33	4,573	0.72
Metal	SOIL	Documentation Issues	Transcription error	Yes	87	4,573	1.90
Metal	SOIL	Holding Times	Holding times were exceeded	No	5	4,573	0.11
Metal	SOIL	Instrument Set-up	Interference was indicated in the interference check sample	No	6	4,573	0.13
Metal	SOIL	Instrument Set-up	Interference was indicated in the interference check sample	Yes	24	4,573	0.52
Metal	SOIL	LCS	CRDL check sample recovery criteria were not met	No	16	4,573	0.35
Metal	SOIL	LCS	CRDL check sample recovery criteria were not met	Yes	22	4,573	0.48
Metal	SOIL	LCS	LCS recovery criteria were not met	No	84	4,573	1.84
Metal	SOIL	LCS	LCS recovery criteria were not met	Yes	274	4,573	5.99
Metal	SOIL	LCS	Low level check sample recovery criteria were not met	No	61	4,573	1.33
Metal	SOIL	LCS	Low level check sample recovery criteria were not met	Yes	37	4,573	0.81
Metal	SOIL	Matrices	Duplicate sample precision criteria were not met	Yes	42	4,573	0.92
Metal	SOIL	Matrices	LCS/LCSD precision criteria were not met	Yes	18	4,573	0.39
Metal	SOIL	Matrices	Percent solids < 30 percent	Yes	39	4,573	0.85
Metal	SOIL	Matrices	Post-digestion MS did not meet control criteria	No	20	4,573	0.44
Metal	SOIL	Matrices	Post-digestion MS did not meet control criteria	Yes	25	4,573	0.55
Metal	SOIL	Matrices	Predigestion MS recovery criteria were not met	No	99	4,573	2.16
Metal	SOIL	Matrices	Predigestion MS recovery criteria were not met	Yes	386	4,573	8.44
Metal	SOIL	Matrices	Predigestion MS recovery was < 30 percent	Yes	13	4,573	0.28
Metal	SOIL	Matrices	Serial dilution criteria were not met	Yes	114	4,573	2.49
Metal	SOIL	Other	IDL is older than 3 months from date of analysis	No	304	4,573	6.65
Metal	SOIL	Other	IDL is older than 3 months from date of analysis	Yes	1,209	4,573	26.44
Metal	SOIL	Other	Result obtained through dilution	Yes	4	4,573	0.09
Metal	SOIL	Other	See hard copy for further explanation	No	9	4,573	0.20
Metal	SOIL	Other	See hard copy for further explanation	Yes	43	4,573	0.94
Metal	SOIL	Sensitivity	IDL changed due to a significant figure discrepancy	No	2	4,573	0.04
Metal	WATER	Blanks	Calibration verification blank contamination	No	384	10,408	3.69
Metal	WATER	Blanks	Calibration verification blank contamination	Yes	38	10,408	0.37
Metal	WATER	Blanks	Method, preparation, or reagent blank contamination	No	482	10,408	4.63
Metal	WATER	Blanks	Method, preparation, or reagent blank contamination	Yes	286	10,408	2.75
Metal	WATER	Blanks	Negative bias indicated in the blanks	No	138	10,408	1.33
Metal	WATER	Blanks	Negative bias indicated in the blanks	Yes	82	10,408	0.79
Metal	WATER	Calculation Errors	Control limits not assigned correctly	No	23	10,408	0.22
Metal	WATER	Calculation Errors	Control limits not assigned correctly	Yes	18	10,408	0.17

162

Table A2.5
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
Metal	WATER	Calibration	Calibration correlation coefficient did not meet requirements	No	51	10,408	0.49
Metal	WATER	Calibration	Calibration correlation coefficient did not meet requirements	Yes	7	10,408	0.07
Metal	WATER	Calibration	Continuing calibration verification criteria were not met	No	7	10,408	0.07
Metal	WATER	Calibration	Continuing calibration verification criteria were not met	Yes	10	10,408	0.10
Metal	WATER	Calibration	Frequency or sequencing verification criteria not met	No	1	10,408	0.01
Metal	WATER	Documentation Issues	Key data fields incorrect	No	56	10,408	0.54
Metal	WATER	Documentation Issues	Key data fields incorrect	Yes	316	10,408	3.04
Metal	WATER	Documentation Issues	Missing deliverables (not required for validation)	No	81	10,408	0.78
Metal	WATER	Documentation Issues	Missing deliverables (not required for validation)	Yes	42	10,408	0.40
Metal	WATER	Documentation Issues	Missing deliverables (required for validation)	No	34	10,408	0.33
Metal	WATER	Documentation Issues	Missing deliverables (required for validation)	Yes	32	10,408	0.31
Metal	WATER	Documentation Issues	Omissions or errors in data package (not required for validation)	No	239	10,408	2.30
Metal	WATER	Documentation Issues	Omissions or errors in data package (not required for validation)	Yes	232	10,408	2.23
Metal	WATER	Documentation Issues	Omissions or errors in data package (required for validation)	No	2	10,408	0.02
Metal	WATER	Documentation Issues	Omissions or errors in data package (required for validation)	Yes	1	10,408	0.01
Metal	WATER	Documentation Issues	Record added by the validator	No	99	10,408	0.95
Metal	WATER	Documentation Issues	Record added by the validator	Yes	125	10,408	1.20
Metal	WATER	Documentation Issues	Transcription error	No	363	10,408	3.49
Metal	WATER	Documentation Issues	Transcription error	Yes	120	10,408	1.15
Metal	WATER	Holding Times	Holding times were exceeded	No	22	10,408	0.21
Metal	WATER	Holding Times	Holding times were exceeded	Yes	1	10,408	0.01
Metal	WATER	Instrument Set-up	AA duplicate injection precision criteria were not met	Yes	3	10,408	0.03
Metal	WATER	Instrument Set-up	Interference was indicated in the interference check sample	No	5	10,408	0.05
Metal	WATER	Instrument Set-up	Interference was indicated in the interference check sample	Yes	12	10,408	0.12
Metal	WATER	LCS	CRDL check sample recovery criteria were not met	No	68	10,408	0.65
Metal	WATER	LCS	CRDL check sample recovery criteria were not met	Yes	74	10,408	0.71
Metal	WATER	LCS	LCS recovery criteria were not met	No	37	10,408	0.36
Metal	WATER	LCS	LCS recovery criteria were not met	Yes	73	10,408	0.70
Metal	WATER	LCS	Low level check sample recovery criteria were not met	No	62	10,408	0.60
Metal	WATER	LCS	Low level check sample recovery criteria were not met	Yes	57	10,408	0.55
Metal	WATER	Matrices	Duplicate sample precision criteria were not met	No	17	10,408	0.16
Metal	WATER	Matrices	Duplicate sample precision criteria were not met	Yes	60	10,408	0.58
Metal	WATER	Matrices	LCS/LCSD precision criteria were not met	No	8	10,408	0.08
Metal	WATER	Matrices	LCS/LCSD precision criteria were not met	Yes	20	10,408	0.19
Metal	WATER	Matrices	MS/MSD precision criteria were not met	No	8	10,408	0.08
Metal	WATER	Matrices	MSA calibration correlation coefficient < 0.995	Yes	1	10,408	0.01
Metal	WATER	Matrices	Post-digestion MS did not meet control criteria	No	111	10,408	1.07
Metal	WATER	Matrices	Post-digestion MS did not meet control criteria	Yes	19	10,408	0.18
Metal	WATER	Matrices	Predigestion MS recovery criteria were not met	No	175	10,408	1.68
Metal	WATER	Matrices	Predigestion MS recovery criteria were not met	Yes	130	10,408	1.25
Metal	WATER	Matrices	Predigestion MS recovery was < 30 percent	No	1	10,408	0.01
Metal	WATER	Matrices	Predigestion MS recovery was < 30 percent	Yes	4	10,408	0.04
Metal	WATER	Matrices	Recovery criteria were not met	Yes	2	10,408	0.02
Metal	WATER	Matrices	Serial dilution criteria were not met	No	10	10,408	0.10
Metal	WATER	Matrices	Serial dilution criteria were not met	Yes	191	10,408	1.84
Metal	WATER	Other	Analysis was not requested according to the statement of work	No	1	10,408	0.01
Metal	WATER	Other	IDL is older than 3 months from date of analysis	No	152	10,408	1.46
Metal	WATER	Other	IDL is older than 3 months from date of analysis	Yes	227	10,408	2.18
Metal	WATER	Other	See hard copy for further explanation	No	17	10,408	0.16
Metal	WATER	Other	See hard copy for further explanation	Yes	41	10,408	0.39

163

Table A2.5
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect ?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
Metal	WATER	Sample Preparation	Samples were not properly preserved in the field	No	76	10,408	0.73
Metal	WATER	Sample Preparation	Samples were not properly preserved in the field	Yes	80	10,408	0.77
Metal	WATER	Sensitivity	IDL changed due to a significant figure discrepancy	No	22	10,408	0.21
PCB	SOIL	Documentation Issues	Transcription error	No	6	238	2.52
PCB	SOIL	Documentation Issues	Transcription error	Yes	1	238	0.42
PCB	SOIL	Holding Times	Holding times were exceeded	No	7	238	2.94
PCB	SOIL	Other	See hard copy for further explanation	Yes	1	238	0.42
PCB	SOIL	Surrogates	Surrogate recovery criteria were not met	No	27	238	11.34
PCB	SOIL	Surrogates	Surrogate recovery criteria were not met	Yes	1	238	0.42
PCB	WATER	Documentation Issues	Record added by the validator	No	7	245	2.86
PCB	WATER	Documentation Issues	Transcription error	No	48	245	19.59
PCB	WATER	Documentation Issues	Transcription error	Yes	1	245	0.41
PCB	WATER	Holding Times	Holding times were exceeded	No	6	245	2.45
PCB	WATER	Holding Times	Holding times were exceeded	Yes	1	245	0.41
PCB	WATER	Surrogates	Surrogate recovery criteria were not met	No	21	245	8.57
Pesticide	SOIL	Blanks	Method, preparation, or reagent blank contamination	No	1	680	0.15
Pesticide	SOIL	Documentation Issues	Transcription error	No	19	680	2.79
Pesticide	SOIL	Documentation Issues	Transcription error	Yes	1	680	0.15
Pesticide	SOIL	Holding Times	Holding times were exceeded	No	23	680	3.38
Pesticide	SOIL	Other	See hard copy for further explanation	No	5	680	0.74
Pesticide	SOIL	Surrogates	Surrogate recovery criteria were not met	No	80	680	11.76
Pesticide	WATER	Blanks	Method, preparation, or reagent blank contamination	No	1	799	0.13
Pesticide	WATER	Calibration	Continuing calibration verification criteria were not met	No	18	799	2.25
Pesticide	WATER	Calibration	Continuing calibration verification criteria were not met	Yes	1	799	0.13
Pesticide	WATER	Confirmation	Results were not confirmed	No	1	799	0.13
Pesticide	WATER	Documentation Issues	Record added by the validator	No	21	799	2.63
Pesticide	WATER	Documentation Issues	Transcription error	No	54	799	6.76
Pesticide	WATER	Documentation Issues	Transcription error	Yes	1	799	0.13
Pesticide	WATER	Holding Times	Holding times were exceeded	No	21	799	2.63
Pesticide	WATER	Internal Standards	Internal standards did not meet criteria	No	1	799	0.13
Pesticide	WATER	Other	See hard copy for further explanation	No	1	799	0.13
Pesticide	WATER	Other	See hard copy for further explanation	Yes	1	799	0.13
Pesticide	WATER	Surrogates	Surrogate recovery criteria were not met	No	82	799	10.26
Radionuclide	SOIL	Blanks	Blank recovery criteria were not met	Yes	13	771	1.69
Radionuclide	SOIL	Blanks	Method, preparation, or reagent blank contamination	Yes	68	771	8.82
Radionuclide	SOIL	Calculation Errors	Calculation error	Yes	10	771	1.30
Radionuclide	SOIL	Calibration	Continuing calibration verification criteria were not met	Yes	20	771	2.59
Radionuclide	SOIL	Documentation Issues	Record added by the validator	Yes	25	771	3.24
Radionuclide	SOIL	Documentation Issues	Results were not included on Data Summary Table	No	1	771	0.13
Radionuclide	SOIL	Documentation Issues	Results were not included on Data Summary Table	Yes	1	771	0.13
Radionuclide	SOIL	Documentation Issues	Sufficient documentation not provided by the laboratory	Yes	139	771	18.03
Radionuclide	SOIL	Documentation Issues	Transcription error	No	1	771	0.13
Radionuclide	SOIL	Documentation Issues	Transcription error	Yes	138	771	17.90
Radionuclide	SOIL	Holding Times	Holding times were grossly exceeded	Yes	6	771	0.78
Radionuclide	SOIL	Instrument Set-up	Detector efficiency did not meet requirements	Yes	28	771	3.63
Radionuclide	SOIL	Instrument Set-up	Resolution criteria were not met	Yes	2	771	0.26
Radionuclide	SOIL	LCS	LCS recovery > +/- 3 sigma	Yes	56	771	7.26
Radionuclide	SOIL	LCS	LCS recovery criteria were not met	Yes	32	771	4.15
Radionuclide	SOIL	LCS	LCS relative percent error criteria not met	Yes	74	771	9.60
Radionuclide	SOIL	Matrices	Recovery criteria were not met	Yes	4	771	0.52
Radionuclide	SOIL	Matrices	Replicate precision criteria were not met	No	1	771	0.13
Radionuclide	SOIL	Matrices	Replicate precision criteria were not met	Yes	96	771	12.45
Radionuclide	SOIL	Matrices	Replicate recovery criteria were not met	Yes	8	771	1.04
Radionuclide	SOIL	Other	Sample exceeded efficiency curve weight limit	Yes	5	771	0.65
Radionuclide	SOIL	Other	See hard copy for further explanation	Yes	11	771	1.43
Radionuclide	SOIL	Other	Tracer requirements were not met	No	1	771	0.13
Radionuclide	SOIL	Other	Tracer requirements were not met	Yes	2	771	0.26
Radionuclide	SOIL	Sensitivity	Incorrect reported activity or MDA	No	1	771	0.13
Radionuclide	SOIL	Sensitivity	Incorrect reported activity or MDA	Yes	1	771	0.13
Radionuclide	SOIL	Sensitivity	MDA exceeded the RDL	Yes	5	771	0.65

164

Table A2.5
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect ?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
Radionuclide	SOIL	Sensitivity	MDA was calculated by reviewer	Yes	187	771	24.25
Radionuclide	SOIL	Sensitivity	Results considered qualitative not quantitative	Yes	1	771	0.13
Radionuclide	WATER	Blanks	Blank data not submitted	Yes	3	3,016	0.10
Radionuclide	WATER	Blanks	Blank recovery criteria were not met	No	8	3,016	0.27
Radionuclide	WATER	Blanks	Blank recovery criteria were not met	Yes	26	3,016	0.86
Radionuclide	WATER	Blanks	Method, preparation, or reagent blank contamination	No	16	3,016	0.53
Radionuclide	WATER	Blanks	Method, preparation, or reagent blank contamination	Yes	106	3,016	3.51
Radionuclide	WATER	Calculation Errors	Calculation error	No	12	3,016	0.40
Radionuclide	WATER	Calculation Errors	Calculation error	Yes	7	3,016	0.23
Radionuclide	WATER	Calibration	Calibration counting statistics did not meet criteria	No	4	3,016	0.13
Radionuclide	WATER	Calibration	Calibration counting statistics did not meet criteria	Yes	1	3,016	0.03
Radionuclide	WATER	Calibration	Continuing calibration verification criteria were not met	No	19	3,016	0.63
Radionuclide	WATER	Calibration	Continuing calibration verification criteria were not met	Yes	150	3,016	4.97
Radionuclide	WATER	Documentation Issues	Information missing from case narrative	No	2	3,016	0.07
Radionuclide	WATER	Documentation Issues	Information missing from case narrative	Yes	5	3,016	0.17
Radionuclide	WATER	Documentation Issues	Missing deliverables (not required for validation)	No	2	3,016	0.07
Radionuclide	WATER	Documentation Issues	Missing deliverables (required for validation)	No	5	3,016	0.17
Radionuclide	WATER	Documentation Issues	Missing deliverables (required for validation)	Yes	6	3,016	0.20
Radionuclide	WATER	Documentation Issues	Omissions or errors in data package (not required for validation)	No	65	3,016	2.16
Radionuclide	WATER	Documentation Issues	Omissions or errors in data package (not required for validation)	Yes	54	3,016	1.79
Radionuclide	WATER	Documentation Issues	Omissions or errors in data package (required for validation)	No	9	3,016	0.30
Radionuclide	WATER	Documentation Issues	Omissions or errors in data package (required for validation)	Yes	11	3,016	0.36
Radionuclide	WATER	Documentation Issues	Record added by the validator	Yes	35	3,016	1.16
Radionuclide	WATER	Documentation Issues	Sufficient documentation not provided by the laboratory	No	2	3,016	0.07
Radionuclide	WATER	Documentation Issues	Sufficient documentation not provided by the laboratory	Yes	129	3,016	4.28
Radionuclide	WATER	Documentation Issues	Transcription error	No	100	3,016	3.32
Radionuclide	WATER	Documentation Issues	Transcription error	Yes	124	3,016	4.11
Radionuclide	WATER	Holding Times	Holding times were exceeded	No	24	3,016	0.80
Radionuclide	WATER	Holding Times	Holding times were exceeded	Yes	68	3,016	2.25
Radionuclide	WATER	Holding Times	Holding times were grossly exceeded	No	9	3,016	0.30
Radionuclide	WATER	Holding Times	Holding times were grossly exceeded	Yes	5	3,016	0.17
Radionuclide	WATER	Instrument Set-up	Resolution criteria were not met	No	5	3,016	0.17
Radionuclide	WATER	Instrument Set-up	Resolution criteria were not met	Yes	16	3,016	0.53
Radionuclide	WATER	Instrument Set-up	Transformed spectral index external site criteria were not met	No	5	3,016	0.17
Radionuclide	WATER	LCS	Expected LCS value not submitted/verifiable	No	3	3,016	0.10
Radionuclide	WATER	LCS	Expected LCS value not submitted/verifiable	Yes	38	3,016	1.26
Radionuclide	WATER	LCS	LCS recovery > +/- 3 sigma	No	40	3,016	1.33
Radionuclide	WATER	LCS	LCS recovery > +/- 3 sigma	Yes	109	3,016	3.61
Radionuclide	WATER	LCS	LCS recovery criteria were not met	No	6	3,016	0.20
Radionuclide	WATER	LCS	LCS recovery criteria were not met	Yes	26	3,016	0.86
Radionuclide	WATER	LCS	LCS relative percent error criteria not met	No	28	3,016	0.93
Radionuclide	WATER	LCS	LCS relative percent error criteria not met	Yes	76	3,016	2.52
Radionuclide	WATER	Matrices	Duplicate analysis was not performed	No	12	3,016	0.40
Radionuclide	WATER	Matrices	Duplicate analysis was not performed	Yes	3	3,016	0.10
Radionuclide	WATER	Matrices	Duplicate sample precision criteria were not met	Yes	5	3,016	0.17
Radionuclide	WATER	Matrices	Recovery criteria were not met	No	5	3,016	0.17
Radionuclide	WATER	Matrices	Recovery criteria were not met	Yes	18	3,016	0.60
Radionuclide	WATER	Matrices	Replicate analysis was not performed	No	2	3,016	0.07
Radionuclide	WATER	Matrices	Replicate analysis was not performed	Yes	20	3,016	0.66
Radionuclide	WATER	Matrices	Replicate precision criteria were not met	No	32	3,016	1.06
Radionuclide	WATER	Matrices	Replicate precision criteria were not met	Yes	144	3,016	4.77
Radionuclide	WATER	Matrices	Replicate recovery criteria were not met	No	1	3,016	0.03
Radionuclide	WATER	Matrices	Replicate recovery criteria were not met	Yes	9	3,016	0.30
Radionuclide	WATER	Other	Lab results not verified due to unsubmitted data	No	2	3,016	0.07

165

Table A2.5
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect ?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
Radionuclide	WATER	Other	Lab results not verified due to unsubmitted data	Yes	6	3,016	0.20
Radionuclide	WATER	Other	QC sample does not meet method requirements	No	18	3,016	0.60
Radionuclide	WATER	Other	QC sample does not meet method requirements	Yes	15	3,016	0.50
Radionuclide	WATER	Other	See hard copy for further explanation	No	57	3,016	1.89
Radionuclide	WATER	Other	See hard copy for further explanation	Yes	120	3,016	3.98
Radionuclide	WATER	Other	Tracer requirements were not met	No	17	3,016	0.56
Radionuclide	WATER	Other	Tracer requirements were not met	Yes	10	3,016	0.33
Radionuclide	WATER	Sample Preparation	Samples were not properly preserved in the field	No	17	3,016	0.56
Radionuclide	WATER	Sample Preparation	Samples were not properly preserved in the field	Yes	11	3,016	0.36
Radionuclide	WATER	Sensitivity	Incorrect reported activity or MDA	No	3	3,016	0.10
Radionuclide	WATER	Sensitivity	Incorrect reported activity or MDA	Yes	13	3,016	0.43
Radionuclide	WATER	Sensitivity	MDA exceeded the RDL	No	15	3,016	0.50
Radionuclide	WATER	Sensitivity	MDA exceeded the RDL	Yes	43	3,016	1.43
Radionuclide	WATER	Sensitivity	MDA was calculated by reviewer	No	18	3,016	0.60
Radionuclide	WATER	Sensitivity	MDA was calculated by reviewer	Yes	292	3,016	9.68
SVOC	SOIL	Blanks	Method, preparation, or reagent blank contamination	No	1	2,472	0.04
SVOC	SOIL	Calibration	Continuing calibration verification criteria were not met	Yes	2	2,472	0.08
SVOC	SOIL	Documentation Issues	Omissions or errors in data package (not required for validation)	No	6	2,472	0.24
SVOC	SOIL	Documentation Issues	Transcription error	No	7	2,472	0.28
SVOC	SOIL	Holding Times	Holding times were exceeded	No	166	2,472	6.72
SVOC	SOIL	Holding Times	Holding times were exceeded	Yes	11	2,472	0.44
SVOC	SOIL	Internal Standards	Internal standards did not meet criteria	No	21	2,472	0.85
SVOC	SOIL	Matrices	Percent solids < 30 percent	Yes	1	2,472	0.04
SVOC	SOIL	Other	See hard copy for further explanation	No	173	2,472	7.00
SVOC	SOIL	Other	See hard copy for further explanation	Yes	2	2,472	0.08
SVOC	WATER	Blanks	Method, preparation, or reagent blank contamination	No	4	2,696	0.15
SVOC	WATER	Calibration	Continuing calibration verification criteria were not met	No	43	2,696	1.59
SVOC	WATER	Calibration	Continuing calibration verification criteria were not met	Yes	1	2,696	0.04
SVOC	WATER	Calibration	Independent calibration verification criteria not met	No	9	2,696	0.33
SVOC	WATER	Documentation Issues	Information missing from case narrative	No	3	2,696	0.11
SVOC	WATER	Documentation Issues	Missing deliverables (not required for validation)	No	6	2,696	0.22
SVOC	WATER	Documentation Issues	Omissions or errors in data package (not required for validation)	No	45	2,696	1.67
SVOC	WATER	Documentation Issues	Omissions or errors in data package (required for validation)	No	6	2,696	0.22
SVOC	WATER	Documentation Issues	Record added by the validator	No	41	2,696	1.52
SVOC	WATER	Documentation Issues	Transcription error	No	11	2,696	0.41
SVOC	WATER	Holding Times	Holding times were exceeded	No	48	2,696	1.78
SVOC	WATER	Holding Times	Holding times were exceeded	Yes	1	2,696	0.04
SVOC	WATER	Instrument Set-up	Instrument tune criteria were not met	No	36	2,696	1.34
SVOC	WATER	Internal Standards	Internal standards did not meet criteria	No	46	2,696	1.71
SVOC	WATER	LCS	LCS recovery criteria were not met	No	10	2,696	0.37
SVOC	WATER	Matrices	MS/MSD precision criteria were not met	No	1	2,696	0.04
SVOC	WATER	Other	See hard copy for further explanation	No	57	2,696	2.11
VOC	SOIL	Blanks	Method, preparation, or reagent blank contamination	No	27	1,443	1.87
VOC	SOIL	Blanks	Method, preparation, or reagent blank contamination	Yes	2	1,443	0.14
VOC	SOIL	Calculation Errors	Calculation error	No	32	1,443	2.22
VOC	SOIL	Calculation Errors	Calculation error	Yes	2	1,443	0.14
VOC	SOIL	Calibration	Continuing calibration verification criteria were not met	No	8	1,443	0.55
VOC	SOIL	Calibration	Continuing calibration verification criteria were not met	Yes	6	1,443	0.42
VOC	SOIL	Documentation Issues	Omissions or errors in data package (not required for validation)	No	118	1,443	8.18
VOC	SOIL	Documentation Issues	Omissions or errors in data package (not required for validation)	Yes	3	1,443	0.21
VOC	SOIL	Documentation Issues	Transcription error	No	36	1,443	2.49
VOC	SOIL	Documentation Issues	Transcription error	Yes	1	1,443	0.07
VOC	SOIL	Holding Times	Holding times were exceeded	No	79	1,443	5.47
VOC	SOIL	Holding Times	Holding times were exceeded	Yes	1	1,443	0.07
VOC	SOIL	Internal Standards	Internal standards did not meet criteria	No	42	1,443	2.91
VOC	SOIL	Matrices	MS/MSD precision criteria were not met	No	8	1,443	0.55

166

Table A2.5
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
VOC	SOIL	Matrices	Percent solids < 30 percent	Yes	2	1,443	0.14
VOC	SOIL	Other	See hard copy for further explanation	No	12	1,443	0.83
VOC	WATER	Blanks	Method, preparation, or reagent blank contamination	No	51	10,280	0.50
VOC	WATER	Blanks	Method, preparation, or reagent blank contamination	Yes	25	10,280	0.24
VOC	WATER	Calibration	Continuing calibration verification criteria were not met	No	207	10,280	2.01
VOC	WATER	Calibration	Continuing calibration verification criteria were not met	Yes	8	10,280	0.08
VOC	WATER	Calibration	Independent calibration verification criteria not met	No	27	10,280	0.26
VOC	WATER	Calibration	Independent calibration verification criteria not met	Yes	7	10,280	0.07
VOC	WATER	Documentation Issues	Information missing from case narrative	No	58	10,280	0.56
VOC	WATER	Documentation Issues	Key data fields incorrect	No	1	10,280	0.01
VOC	WATER	Documentation Issues	Missing deliverables (not required for validation)	No	110	10,280	1.07
VOC	WATER	Documentation Issues	Omissions or errors in data package (not required for validation)	No	795	10,280	7.73
VOC	WATER	Documentation Issues	Omissions or errors in data package (not required for validation)	Yes	23	10,280	0.22
VOC	WATER	Documentation Issues	Omissions or errors in data package (required for validation)	No	109	10,280	1.06
VOC	WATER	Documentation Issues	Omissions or errors in data package (required for validation)	Yes	1	10,280	0.01
VOC	WATER	Documentation Issues	Record added by the validator	No	134	10,280	1.30
VOC	WATER	Documentation Issues	Record added by the validator	Yes	1	10,280	0.01
VOC	WATER	Documentation Issues	Transcription error	No	417	10,280	4.06
VOC	WATER	Documentation Issues	Transcription error	Yes	8	10,280	0.08
VOC	WATER	Holding Times	Holding times were exceeded	No	625	10,280	6.08
VOC	WATER	Holding Times	Holding times were exceeded	Yes	8	10,280	0.08
VOC	WATER	Instrument Set-up	Instrument tune criteria were not met	No	629	10,280	6.12
VOC	WATER	Instrument Set-up	Instrument tune criteria were not met	Yes	32	10,280	0.31
VOC	WATER	Internal Standards	Internal standards did not meet criteria	No	147	10,280	1.43
VOC	WATER	LCS	LCS recovery criteria were not met	No	85	10,280	0.83
VOC	WATER	LCS	LCS recovery criteria were not met	Yes	9	10,280	0.09
VOC	WATER	Matrices	MS/MSD precision criteria were not met	No	10	10,280	0.10
VOC	WATER	Matrices	MS/MSD precision criteria were not met	Yes	3	10,280	0.03
VOC	WATER	Other	Sample results were not validated due to re-analysis	No	6	10,280	0.06
VOC	WATER	Other	See hard copy for further explanation	No	55	10,280	0.54
VOC	WATER	Other	See hard copy for further explanation	Yes	1	10,280	0.01
VOC	WATER	Surrogates	Surrogate recovery criteria were not met	No	30	10,280	0.29
VOC	WATER	Surrogates	Surrogate recovery criteria were not met	Yes	6	10,280	0.06
Wet Chemistry	SOIL	Blanks	Calibration verification blank contamination	Yes	1	121	0.83
Wet Chemistry	SOIL	Documentation Issues	Record added by the validator	Yes	2	121	1.65
Wet Chemistry	SOIL	Holding Times	Holding times were exceeded	No	1	121	0.83
Wet Chemistry	SOIL	Holding Times	Holding times were exceeded	Yes	4	121	3.31
Wet Chemistry	SOIL	Matrices	Percent solids < 30 percent	Yes	2	121	1.65
Wet Chemistry	SOIL	Matrices	Predigestion MS recovery criteria were not met	No	1	121	0.83
Wet Chemistry	SOIL	Matrices	Predigestion MS recovery criteria were not met	Yes	49	121	40.50
Wet Chemistry	SOIL	Matrices	Predigestion MS recovery was < 30 percent	Yes	43	121	35.54
Wet Chemistry	SOIL	Matrices	Serial dilution criteria were not met	Yes	4	121	3.31
Wet Chemistry	SOIL	Other	IDL is older than 3 months from date of analysis	Yes	50	121	41.32
Wet Chemistry	WATER	Blanks	Calibration verification blank contamination	No	1	1,071	0.09
Wet Chemistry	WATER	Blanks	Method, preparation, or reagent blank contamination	No	3	1,071	0.28
Wet Chemistry	WATER	Blanks	Method, preparation, or reagent blank contamination	Yes	2	1,071	0.19
Wet Chemistry	WATER	Blanks	Negative bias indicated in the blanks	No	3	1,071	0.28
Wet Chemistry	WATER	Blanks	Negative bias indicated in the blanks	Yes	1	1,071	0.09
Wet Chemistry	WATER	Calculation Errors	Control limits not assigned correctly	Yes	1	1,071	0.09
Wet Chemistry	WATER	Calibration	Calibration correlation coefficient did not meet requirements	Yes	7	1,071	0.65
Wet Chemistry	WATER	Calibration	Continuing calibration verification criteria were not met	Yes	2	1,071	0.19
Wet Chemistry	WATER	Documentation Issues	Omissions or errors in data package (not required for validation)	No	2	1,071	0.19

1617

Table A2.5
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect ?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
Wet Chemistry	WATER	Documentation Issues	Omissions or errors in data package (not required for validation)	Yes	13	1,071	1.21
Wet Chemistry	WATER	Documentation Issues	Omissions or errors in data package (required for validation)	Yes	1	1,071	0.09
Wet Chemistry	WATER	Documentation Issues	Record added by the validator	No	26	1,071	2.43
Wet Chemistry	WATER	Documentation Issues	Record added by the validator	Yes	21	1,071	1.96
Wet Chemistry	WATER	Documentation Issues	Transcription error	No	17	1,071	1.59
Wet Chemistry	WATER	Documentation Issues	Transcription error	Yes	15	1,071	1.40
Wet Chemistry	WATER	Holding Times	Holding times were exceeded	No	13	1,071	1.21
Wet Chemistry	WATER	Holding Times	Holding times were exceeded	Yes	7	1,071	0.65
Wet Chemistry	WATER	Holding Times	Holding times were grossly exceeded	No	13	1,071	1.21
Wet Chemistry	WATER	Holding Times	Holding times were grossly exceeded	Yes	3	1,071	0.28
Wet Chemistry	WATER	Matrices	Duplicate sample precision criteria were not met	Yes	2	1,071	0.19
Wet Chemistry	WATER	Matrices	Predigestion MS recovery criteria were not met	No	4	1,071	0.37
Wet Chemistry	WATER	Matrices	Predigestion MS recovery criteria were not met	Yes	22	1,071	2.05
Wet Chemistry	WATER	Matrices	Predigestion MS recovery was < 30 percent	Yes	2	1,071	0.19
Wet Chemistry	WATER	Other	Lab results not verified due to unsubmitted data	Yes	14	1,071	1.31
Wet Chemistry	WATER	Other	See hard copy for further explanation	No	2	1,071	0.19
Wet Chemistry	WATER	Other	See hard copy for further explanation	Yes	4	1,071	0.37
Wet Chemistry	WATER	Sample Preparation	Preservation requirements were not met by the laboratory	Yes	8	1,071	0.75
Wet Chemistry	WATER	Sample Preparation	Samples were not properly preserved in the field	Yes	14	1,071	1.31

168

Table A2.6
Summary of Data Rejected During V&V

Analyte Group	Matrix	Total No. of Rejected Records	Total No. of Records	Percent Rejected (%)
Dioxins and Furans	SOIL	0	68	0.00
Dioxins and Furans	WATER	2	27	7.41
Herbicide	SOIL	3	60	5.00
Herbicide	WATER	3	132	2.27
Metal	SOIL	106	7,163	1.48
Metal	WATER	548	17,346	3.16
PCB	SOIL	28	434	6.45
PCB	WATER	0	427	0.00
Pesticide	SOIL	87	1,262	6.89
Pesticide	WATER	1	1,364	0.07
Radionuclide	SOIL	298	1,828	16.30
Radionuclide	WATER	737	5,421	13.60
SVOC	SOIL	189	3,569	5.30
SVOC	WATER	67	4,950	1.35
VOC	SOIL	153	3,384	4.52
VOC	WATER	592	15,900	3.72
Wet Chemistry	SOIL	1	190	0.53
Wet Chemistry	WATER	29	1,764	1.64
	Total	**2,844**	**65,289**	**4.36%**

169

Table A2.7
Summary of RPDs/DERs of Field Duplicate Analyte Pairs

Analyte Group	Matrix	No. of Duplicates Failing RPD/DER Criteria	Total No. of Duplicate Pairs	Percent Failure (%)	Field Duplicate Frequency (%)
Metal	SOIL	47	449	10.47	9.81
Metal	WATER	29	784	3.70	6.25
Pesticide	SOIL	0	23	0.00	3.03
Radionuclide	SOIL	10	74	13.51	9.02
Radionuclide	WATER	2	286	0.70	3.75
SVOC	SOIL	0	115	0.00	4.64
SVOC	WATER	0	419	0.00	9.91
VOC	SOIL	1	71	1.41	4.70
VOC	WATER	0	697	0.00	5.28
Wet Chemistry	SOIL	0	10	0.00	8.26
Wet Chemistry	WATER	0	52	0.00	3.22

170

Table A2.8
Summary of Data Estimated or Undetected Due to V&V Determinations

Analyte Group	Matrix	No. of CRA Data Records Qualified	Total No. of V&V CRA Records	Detect?	Percent Qualified (%)
Dioxins and Furans	SOIL	1	68	Yes	1.47
Herbicide	SOIL	6	42	No	14.29
Herbicide	WATER	34	93	No	36.56
Metal	SOIL	426	4,573	No	9.32
Metal	SOIL	891	4,573	Yes	19.48
Metal	WATER	1,433	10,408	No	13.77
Metal	WATER	965	10,408	Yes	9.27
PCB	SOIL	34	238	No	14.29
PCB	WATER	27	245	No	11.02
Pesticide	SOIL	106	680	No	15.59
Pesticide	WATER	116	799	No	14.52
Radionuclide	SOIL	2	771	Yes	0.26
Radionuclide	WATER	14	3,016	No	0.46
Radionuclide	WATER	36	3,016	Yes	1.19
SVOC	SOIL	347	2,472	No	14.04
SVOC	WATER	205	2,696	No	7.60
SVOC	WATER	1	2,696	Yes	0.04
VOC	SOIL	163	1,443	No	11.30
VOC	SOIL	9	1,443	Yes	0.62
VOC	WATER	1,107	10,280	No	10.77
VOC	WATER	38	10,280	Yes	0.37
Wet Chemistry	SOIL	2	121	No	1.65
Wet Chemistry	SOIL	99	121	Yes	81.82
Wet Chemistry	WATER	35	1,071	No	3.27
Wet Chemistry	WATER	64	1,071	Yes	5.98
	Total	**6,161**	**39,030**		**15.79%**

171

Table A2.9
Summary of Data Qualified as Undetected Due to Blank Contamination

Analyte Group	Matrix	No. of CRA Records Qualified as Undetected	Total No. of CRA Records with Detected Results[a]	Percent Qualified as Undetected
Metal	SOIL	105	3,558	2.95
Metal	WATER	233	4,762	4.89
	Total	**338**	**8,320**	**4.06%**

[a] As determined by the laboratory prior to V&V.

172

COMPREHENSIVE RISK ASSESSMENT

LOWER WOMAN DRAINAGE EXPOSURE UNIT

VOLUME 11: ATTACHMENT 3

Statistical Analyses and Professional Judgment

TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS vii
1.0 INTRODUCTION 1
2.0 RESULTS OF STATISTICAL COMPARISONS TO BACKGROUND FOR THE LOWER WOMAN EXPOSURE UNIT 1
2.1 Surface Soil/Surface Sediment Data Used in the Human Health Risk Assessment 2
2.2 Subsurface Soil/Subsurface Sediment Used in the HHRA 2
2.3 Surface Soil Used in the ERA (Non-PMJM Receptors) 3
2.4 Surface Soil Data Used in the ERA (PMJM Receptors) 4
2.5 Subsurface Soil Data Used in the ERA 4
3.0 Upper-Bound Exposure Point Concentration Comparison to Limiting Ecological Screening levels 5
3.1 ECOIs in Surface Soil 5
3.2 ECOIs in Subsurface Soil 5
4.0 PROFESSIONAL JUDGMENT 5
4.1 Aluminum 7
4.1.1 Summary of Process Knowledge 7
4.1.2 Evaluation of Spatial Trends 8
4.1.3 Pattern Recognition 8
4.1.4 Comparison to RFETS Background and Other Background Data Sets 8
4.1.5 Risk Potential for Plants and Wildlife 8
4.1.6 Conclusion 8
4.2 Antimony 9
4.2.1 Summary of Process Knowledge 9
4.2.2 Evaluation of Spatial Trends 9
4.2.3 Pattern Recognition 9
4.2.4 Comparison to RFETS Background and Other Background Data Sets 9
4.2.5 Risk Potential for Plants and Wildlife 10
4.2.6 Conclusion 10
4.3 Arsenic 10
4.3.1 Summary of Process Knowledge 10
4.3.2 Evaluation of Spatial Trends 11
4.3.3 Pattern Recognition 11
4.3.4 Comparison to RFETS Background and Other Background Data Sets 11
4.3.5 Risk Potential for HHRA 11
4.3.6 Conclusion 11
4.4 Boron 12
4.4.1 Summary of Process Knowledge 12
4.4.2 Evaluation of Spatial Trends 12
4.4.3 Pattern Recognition 12

174

4.4.4 Comparison to RFETS Background and Other Background Data Sets 12
4.4.5 Risk Potential for Plants and Wildlife 12
4.4.6 Conclusion 13
4.5 Chromium 13
4.5.1 Summary of Process Knowledge 13
4.5.2 Evaluation of Spatial Trends 13
4.5.3 Conclusion 14
4.6 Copper 14
4.6.1 Summary of Process Knowledge 14
4.6.2 Evaluation of Spatial Trends 14
4.6.3 Conclusion 14
4.7 Lithium 15
4.7.1 Summary of Process Knowledge 15
4.7.2 Evaluation of Spatial Trends 15
4.7.3 Pattern Recognition 15
4.7.4 Comparison to RFETS Background and Other Background Data Sets 15
4.7.5 Risk Potential for Plants and Wildlife 16
4.7.6 Conclusion 16
4.8 Manganese 16
4.8.1 Summary of Process Knowledge 16
4.8.2 Evaluation of Spatial Trends 16
4.8.3 Pattern Recognition 17
4.8.4 Comparison to RFETS Background and Other Background Data Sets 17
4.8.5 Risk Potential for HHRA 17
4.8.6 Conclusion 17
4.9 Nickel 17
4.9.1 Summary of Process Knowledge 18
4.9.2 Evaluation of Spatial Trends 18
4.9.3 Conclusion 18
4.10 Radium-228 18
4.10.1 Summary of Process Knowledge 18
4.10.2 Evaluation of Spatial Trends 19
4.10.3 Pattern Recognition 19
4.10.4 Comparison to RFETS Background and Other Background Data Sets 19
4.10.5 Risk Potential for HHRA 19
4.10.6 Conclusion 19
4.11 Selenium 20
4.11.1 Summary of Process Knowledge 20
4.11.2 Evaluation of Spatial Trends 20
4.11.3 Conclusion 20
4.12 Thallium 20

4.12.1 Summary of Process Knowledge 20
4.12.2 Evaluation of Spatial Trends 20
4.12.3 Conclusion 21
4.13 Tin 21
4.13.1 Summary of Process Knowledge 21
4.13.2 Evaluation of Spatial Trends 21
4.13.3 Conclusion 21
4.14 Vanadium 21
4.14.1 Summary of Process Knowledge 22
4.14.2 Evaluation of Spatial Trends 22
4.14.3 Conclusion 22
4.15 Zinc 22
4.15.1 Summary of Process Knowledge 23
4.15.2 Evaluation of Spatial Trends 23
4.15.3 Pattern Recognition 23
4.15.4 Comparison to RFETS Background and Other Background Data Sets 23
4.15.5 Risk Potential for Plants and Wildlife 23
4.15.6 Conclusion 24
5.0 REFERENCES 24

LIST OF TABLES

Table A3.2.1 Statistical Distributions and Comparison to Background for LWOEU Surface Soil/Surface Sediment

Table A3.2.2 Summary Statistics for Background and LWOEU Surface Soil/Surface Sediment

Table A3.2.3 Statistical Distributions and Comparison to Background for LWOEU Subsurface Soil/Subsurface Sediment

Table A3.2.4 Summary Statistics for Background and LWOEU Subsurface Soil/Subsurface Sediment

Table A3.2.5 Statistical Distributions and Comparison to Background for LWOEU Surface Soil

Table A3.2.6 Summary Statistics for Background and LWOEU Surface Soil

Table A3.2.7 Statistical Distributions and Comparison to Background for Surface Soil in PMJM Habitat in the LWOEU

Table A3.2.8 Summary Statistics for Background and LWOEU Surface Soil in PMJM Habitat

Table A3.2.9 Statistical Distributions and Comparison to Background for LWOEU Subsurface Soil

Table A3.2.10 Summary Statistics for Background and LWOEU Subsurface Soil

175

Table A3.4.1 Summary of Element Soil Concentrations in Colorado and Bordering States

LIST OF FIGURES

Figure A3.2.1 LWOEU Surface Soil Box Plots for Aluminum

Figure A3.2.2 LWOEU Subsurface Soil Box Plots for Antimony

Figure A3.2.3 LWOEU Surface Soil/Surface Sediment Box Plots for Arsenic

Figure A3.2.4 LWOEU Surface Soil Box Plots for Arsenic

Figure A3.2.5 LWOEU Subsurface Soil Box Plots for Arsenic

Figure A3.2.6 LWOEU Surface Soil Box Plots for Barium

Figure A3.2.7 LWOEU Surface Soil Box Plots for Cadmium

Figure A3.2.8 LWOEU Surface Soil/Surface Sediment Box Plots for Cesium-134

Figure A3.2.9 LWOEU Surface Soil/Surface Sediment Box Plots for Cesium-137

Figure A3.2.10 LWOEU Surface Soil Box Plots for Chromium

Figure A3.2.11 LWOEU Surface Soil (PMJM) Box Plots for Chromium

Figure A3.2.12 LWOEU Surface Soil Box Plots for Cobalt

Figure A3.2.13 LWOEU Surface Soil Box Plots for Copper

Figure A3.2.14 LWOEU Surface Soil Box Plots for Lead

Figure A3.2.15 LWOEU Surface Soil Box Plots for Lithium

Figure A3.2.16 LWOEU Surface Soil/Surface Sediment Box Plots for Manganese

Figure A3.2.17 LWOEU Surface Soil Box Plots for Manganese

Figure A3.2.18 LWOEU Surface Soil (PMJM) Box Plots for Manganese

Figure A3.2.19 LWOEU Surface Soil Box Plots for Mercury

Figure A3.2.20 LWOEU Surface Soil Box Plots for Nickel

Figure A3.2.21 LWOEU Surface Soil (PMJM) Box Plots for Nickel

Figure A3.2.22 LWOEU Subsurface Soil Box Plots for Nickel

Figure A3.2.23 LWOEU Surface Soil/Surface Sediment Box Plots for Radium-228

Figure A3.2.24 LWOEU Subsurface Soil/Subsurface Sediment Box Plots for Radium-228

Figure A3.2.25 LWOEU Surface Soil Box Plots for Selenium

Figure A3.2.26 LWOEU Surface Soil (PMJM) Box Plots for Selenium

Figure A3.2.27 LWOEU Surface Soil Box Plots for Vanadium

Figure A3.2.28 LWOEU Surface Soil (PMJM) Box Plots for Vanadium

Figure A3.2.29	LWOEU Subsurface Soil Box Plots for Vanadium
Figure A3.2.30	LWOEU Surface Soil Box Plots for Zinc
Figure A3.2.31	LWOEU Surface Soil (PMJM) Box Plots for Zinc
Figure A3.4.1	Probability Plot of Aluminum Concentrations in LWOEU Surface Soil
Figure A3.4.2	Probability Plot of Antimony Concentrations (Natural Logarithm) in LWOEU Surface Soil
Figure A3.4.3	Probability Plot of Antimony Concentrations in LWOEU Subsurface Soil
Figure A3.4.4	Probability Plot of Arsenic Concentrations (Natural Logarithm) in LWOEU Surface Soil/Surface Sediment
Figure A3.4.5	Probability Plot of Boron Concentrations in LWOEU Surface Soil
Figure A3.4.6	Probability Plot of Lithium Concentrations in LWOEU Surface Soil
Figure A3.4.7	Probability Plot of Manganese Concentrations in LWOEU Surface Soil/Surface Sediment
Figure A3.4.8	Radium-228 Activity in Sitewide Surface Soil/Surface Sediment
Figure A3.4.9	Probability Plot of Radium-228 Activity in LWOEU Surface Soil/Surface Sediment
Figure A3.4.10	Probability Plot of Zinc Concentrations in LWOEU Surface Soil

176

ACRONYMS AND ABBREVIATIONS

CDH	Colorado Department of Health
COC	contaminant of concern
ECOI	ecological contaminant of interest
ECOPC	ecological contaminant of potential concern
EcoSSL	Ecological Soil Screening Level
EPC	exposure point concentration
ERA	Ecological Risk Assessment
ESL	ecological screening level
EU	Exposure Unit
HHRA	Human Health Risk Assessment
IHSS	Individual Hazardous Substance Site
LWOEU	Lower Woman Drainage Exposure Unit
MDC	maximum detected concentration
mg/kg	milligrams per kilogram
NCP	National Contingency Plan
NFA	No Further Action
NOAEL	no observed adverse effect level
PCOC	potential contaminant of concern
pCi/g	picocuries per gram
PMJM	Preble's meadow jumping mouse
PRG	preliminary remediation goal
RFETS	Rocky Flats Environmental Technology Site
RI/FS	Remedial Investigation/Feasibility Report

tESL	threshold ecological screening level
UCL	upper confidence limit
UTL	upper tolerance limit
WRW	wildlife refuge worker

177

1.0 INTRODUCTION

This attachment presents the results for the statistical analyses and professional judgment evaluation used to select human health contaminants of concern (COCs) as part of the Human Health Risk Assessment (HHRA) and ecological contaminants of potential concern (ECOPCs) as part of the Ecological Risk Assessment (ERA) for the Lower Woman Drainage Exposure Unit (EU) (LWOEU) at the Rocky Flats Environmental Technology Site (RFETS). The methods used to perform the statistical analysis and to develop the professional judgment sections are described in Appendix A, Volume 2, Section 2.0 of the Resource Conservation and Recovery Act (RCRA) Facility Investigation-Remedial Investigation/Corrective Measures Study (CMS)-Feasibility Study (RI/FS) Report (hereafter referred to as the RI/FS Report), and follow the Final Comprehensive Risk Assessment (CRA) Work Plan and Methodology (DOE 2005).

2.0 RESULTS OF STATISTICAL COMPARISONS TO BACKGROUND FOR THE LOWER WOMAN EXPOSURE UNIT

The results of the statistical background comparisons for inorganic and radionuclide potential contaminants of concern (PCOCs) and ecological contaminants of interest (ECOIs) in surface soil/surface sediment, subsurface soil/subsurface sediment, surface soil, and subsurface soil samples collected from the LWOEU are presented in this section. Box plots are provided for analytes that were carried forward into the statistical comparison step and are presented in Figures A3.2.1 to A3.2.31.[1] The box plots display several reference points: 1) the line inside the box is the median; 2) the lower edge of the box is the 25th percentile; 3) the upper edge of the box is the 75th percentile; 4) the upper lines (called whiskers) are drawn to the greatest value that is less than or equal to 1.5 times the inter-quartile range (the inter-quartile range is between the 75th and 25th percentiles); 5) the lower whiskers are drawn to the lowest value that is greater than or equal to 1.5 times the inter-quartile range; and 6) solid circles are data points greater or less than the whiskers.

ECOIs for surface soil (Preble's meadow jumping mouse [PMJM] receptor) and PCOCs with concentrations in the LWOEU that are statistically greater than background (or those where background comparisons were not performed) are carried through to the professional judgment step of the COC/ECOPC selection processes. ECOIs (for non-PMJM receptors) with concentrations in the LWOEU that are statistically greater than background (or those where background comparisons were not performed) are carried through to the exposure point concentration (EPC) – threshold ecological screening level (tESL) comparison step of the ECOPC selection processes.

[1] Statistical background comparisons are not performed for analytes if: 1) the background concentrations are nondetections; 2) background data are unavailable; 3) the analyte has low detection frequency in the LWOEU or background data set (less than 20 percent); or 4) the analyte is an organic compound. Box plots are not provided for these analytes. However, these analytes are carried forward into the professional judgment evaluation.

PCOCs and ECOIs with concentrations that are not statistically greater than background are not identified as COCs/ECOPCs and are not evaluated further.

2.1 Surface Soil/Surface Sediment Data Used in the Human Health Risk Assessment

For the LWOEU surface soil/surface sediment data set, the maximum detected concentrations (MDCs) and upper confidence limits (UCLs) on the mean for arsenic, manganese, cesium-134, cesium-137, and radium-228 exceed the wildlife refuge worker (WRW) preliminary remediation goals (PRGs) for the LWOEU data set, and these PCOCs were carried forward into the statistical background comparison step. The results of the statistical comparison of the LWOEU surface soil/surface sediment data to background data for these PCOCs are presented in Table A3.2.1 and the summary statistics for background and LWOEU surface soil/surface sediment data are shown in Table A3.2.2. The LWOEU MDCs and UCLs for all other PCOCs do not exceed the PRGs and were not evaluated further.

The results of the statistical comparisons of the LWOEU surface soil/surface sediment data to background data indicate the following:

Statistically Greater than Background at the 0.1 Significance Level

- Arsenic
- Manganese
- Radium-228

Not Statistically Greater than Background at the 0.1 Significance Level

- Cesium-134
- Cesium-137

Background Comparison Not Performed[1]

- None

2.2 Subsurface Soil/Subsurface Sediment Used in the HHRA

For the LWOEU subsurface soil/subsurface sediment data set, the MDC and UCL for radium-228 exceeded the WRW PRG for the LWOEU data set, and this PCOC was carried forward into the statistical background comparison step. The results of the statistical comparison of the LWOEU subsurface soil/subsurface sediment data to background data for this PCOC is presented in Table A3.2.3, and the summary statistics for background and LWOEU subsurface soil/subsurface sediment data are shown in Table A3.2.4.

The results of the statistical comparisons of the LWOEU subsurface soil/subsurface sediment data to background data indicate the following:

Statistically Greater than Background at the 0.1 Significance Level

- None

Not Statistically Greater than Background at the 0.1 Significance Level

- Radium-228

Background Comparison Not Performed[1]

- None

2.3 Surface Soil Used in the ERA (Non-PMJM Receptors)

For the ECOIs in surface soil, the MDCs for aluminum, antimony, arsenic, barium, boron, cadmium, chromium, cobalt, copper, lead, lithium, manganese, mercury, nickel, selenium, thallium, tin, vanadium, and zinc exceeded a non-PMJM ESL, and these ECOIs were carried forward into the statistical background comparison step. The results of the statistical comparison of the LWOEU surface soil data to background data are presented in Table A3.2.5 and the summary statistics for background and LWOEU surface soil data are shown in Table A3.2.6.

The results of the statistical comparisons of the LWOEU surface soil to background data indicate the following:

Statistically Greater than Background at the 0.1 Significance Level

- Aluminum
- Barium
- Chromium
- Copper
- Lithium
- Manganese
- Nickel
- Vanadium
- Zinc

Not Statistically Greater than Background at the 0.1 Significance Level

- Arsenic
- Cadmium
- Cobalt
- Lead
- Mercury
- Selenium

Background Comparison Not Performed[1]

- Antimony
- Boron

- Thallium
- Tin

2.4 Surface Soil Data Used in the ERA (PMJM Receptors)

For the ECOIs in surface soil in PMJM habitat, the MDCs for arsenic, chromium, copper, manganese, nickel, selenium, tin, vanadium and zinc exceed the PMJM ESL, and were carried forward into the background comparison step. The results of the statistical comparison of the LWOEU surface soil data in PMJM habitat to background data are presented in Table A3.2.7. The summary statistic for background and LWOEU surface soil in PMJM habitats are shown in Table A3.2.8.

The results of the statistical comparisons of the LWOEU surface soil in PMJM habitat to background data indicate the following:

Statistically Greater than Background at the 0.1 Significance Level

- Chromium
- Copper
- Manganese
- Nickel
- Vanadium
- Zinc

Not Statistically Greater than Background at the 0.1 Significance Level

- Arsenic
- Mercury

Background Comparison Not Performed[1]

- Selenium
- Tin

2.5 Subsurface Soil Data Used in the ERA

For the ECOIs in subsurface soil, the MDC for antimony, arsenic, nickel, and vanadium exceeded the prairie dog ESL and was carried forward into the statistical background comparison step. The MDCs for all other ECOIs do not exceed the prairie dog ESL. The results of the statistical comparison of the LWOEU subsurface soil data to background data are presented in Table A3.2.9 and the summary statistics for background and LWOEU subsurface soil data are shown in Table A3.2.10.

The results of the statistical comparisons of the surface soil data to background data indicate the following:

Statistically Greater than Background at the 0.1 Significance Level

- Arsenic

- Vanadium

Not Statistically Greater than Background at the 0.1 Significance Level

- Nickel

Background Comparison Not Performed[1]

- Antimony

3.0 UPPER-BOUND EXPOSURE POINT CONCENTRATION COMPARISON TO LIMITING ECOLOGICAL SCREENING LEVELS

ECOIs in surface soil and subsurface soil with concentrations that are statistically greater than background, if background comparisons were not performed, are evaluated further by comparing the LWOEU EPCs to the tESLs. The EPCs are the 95 percent UCLs of the 90th percentile (upper tolerance limit [UTL]) for small home-range receptors, the UCL for large home-range receptors, or the MDC in the event that the UCL or UTL is greater than the MDC.

3.1 ECOIs in Surface Soil

Barium in surface soil (non-PMJM) was eliminated from further consideration because the EPC is not greater than the limiting tESLs. Aluminum, antimony, boron, chromium, copper, lithium, manganese, nickel, thallium, tin, vanadium, and zinc have EPCs greater than the limiting tESLs and are evaluated in the professional judgment evaluation screening step (Section 4.0).

3.2 ECOIs in Subsurface Soil

Vanadium and arsenic in subsurface soil were eliminated from further consideration because the EPCs is not greater than the tESLs. Antimony has an EPC greater than the limiting tESL and is evaluated in the professional judgment evaluation screening step (Section 4.0).

4.0 PROFESSIONAL JUDGMENT

This section presents the results of the professional judgment step of the COC and ECOPC selection processes for the HHRA and ERA, respectively. Based on the weight of evidence evaluated in the professional judgment step, PCOCs and ECOIs are either included for further evaluation as COCs/ECOPCs in the risk characterization step, or excluded from further evaluation.

The professional judgment evaluation takes into account the following lines of evidence: process knowledge, spatial trends, pattern recognition[2], comparison to RFETS

[2] The pattern recognition evaluation includes the use of probability plots. If two or more distinct populations are evident in the probability plot, this suggests that one or more local releases may have occurred. Conversely, if only one distinct low-concentration population is defined, likely representing a background population, a local release may or may not have occurred. Similar to all statistical methods, the probability plot has limitations in cases where there is inadequate sampling and the magnitude of the release is relatively small. Thus, absence of two clear populations in the probability plots is consistent with,

180

background and regional background data sets (see Table A3.4.1 for a summary of regional background data)[3], and risk potential. For PCOCs or ECOIs where the process knowledge and/or spatial trends indicate that the presence of the analyte in the EU may be a result of historical site-related activities, the professional judgment discussion includes only two of the lines of evidence listed above, and it is concluded that these analytes are COCs/ECOPCs and are carried forward into risk characterization. For the other PCOCs and ECOIs that are evaluated in the professional judgment step, each of the lines of evidence listed above is included in the discussion.

For metals, Appendix A, Volume 2, Attachment 8 of the RI/FS Report provides the details of the process knowledge and spatial trend evaluations. The conclusions from these evaluations are noted in this attachment.

The following PCOCs/ECOIs are evaluated further in the professional judgment step for LWOEU:

- Surface soil/surface sediment (HHRA)
  - Arsenic
  - Manganese
  - Radium-228
- Subsurface soil/subsurface sediment (HHRA)
  - No PCOCs were found to be statistically greater than background and above a PRG in accordance with the COC selection process; therefore, no PCOCs in subsurface soil/subsurface sediment are evaluated using professional judgment.
- Surface soil for non-PMJM receptors (ERA)
  - Aluminum
  - Antimony
  - Boron
  - Chromium
  - Copper
  - Lithium

but not definitive proof of, the hypothesis that no releases have occurred. However, if a release has occurred within the sampled area and has been included in the samples, then the elemental concentrations associated with that release are either within the background concentration range or the entire sampled population represents a release, a highly unlikely probability.

[3] The regional background data set for Colorado and the bordering states was extracted from data for the western United States (Shacklette and Boerngen 1984) and is composed of data from Colorado as well as Arizona, Kansas, Nebraska, New Mexico, Oklahoma, Utah, and Wyoming. Although the Colorado and bordering states background data set is not specific to Colorado's Front Range, it is useful for the professional judgment evaluation in the absence of a robust data set for the Front Range. Colorado's Front Range has highly variable terrain that changes elevation over short distances. Consequently, numerous soil types and geologic materials are present at RFETS, and the data set for Colorado and bordering states may be more representative of these variable soil types.

  - Manganese
  - Nickel
  - Thallium
  - Tin
  - Vanadium
  - Zinc
- Surface soil for PMJM receptors (ERA)
  - Chromium
  - Copper
  - Manganese
  - Nickel
  - Selenium
  - Tin
  - Vanadium
  - Zinc
- Subsurface soil (ERA)
  - Antimony

The following sections provide the professional judgment evaluations, by analyte and by medium, for the PCOCs/ECOIs listed above.

4.1 Aluminum

Aluminum has an EPC in surface soil (for non-PMJM receptors) greater than the limiting tESL, and therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if aluminum should be retained for risk characterization are summarized below.

4.1.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates a potential for aluminum to have been released into RFETS soil because of the large aluminum metal inventory and presence of aluminum in waste generated during former operations. However, these sources of historic use are remote from the LWOEU. Therefore, aluminum is unlikely to be present in LWOEU soil as a result of historical site-related activities.

181

4.1.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that aluminum concentrations in LWOEU surface soil reflect variations in naturally occurring aluminum.

4.1.3 Pattern Recognition

Surface Soil (Non-PMJM)

The probability plot for aluminum in surface soil (Figure A3.4.1) suggests the presence of a single population, which is indicative of background conditions.

4.1.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

Aluminum concentrations in LWOEU surface soil range from 3,900 to 30,000 milligram per kilogram (mg/kg), with a mean concentration of 15,019 mg/kg and a standard deviation of 6,250 mg/kg. Aluminum concentrations in the background data set range from 4,050 to 17,100 mg/kg, with a mean concentration of 10,203 mg/kg and a standard deviation of 3,256 mg/kg (Table A3.2.6).

Aluminum concentrations in LWOEU surface soil are well within the range for aluminum in soils of Colorado and the bordering states (5,000 to 100,000 mg/kg, with a mean concentration of 50,800 mg/kg and a standard deviation of 23,500 mg/kg) (Table A3.4.1).

4.1.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The MDC for aluminum in the LWOEU (30,000 mg/kg) exceeds the no observed adverse effect level (NOAEL) ESL for only one receptor group, terrestrial plants (50 mg/kg). However, EPA Ecological Soil Screening Level (EcoSSL) guidance (EPA 2003 and 2005) recommends that aluminum should not be considered an ECOPC for soils at sites where the pH of the soil exceeds 5.5 due to its limited bioavailability in non-acidic soils. Average pH values at RFETS are 8.2 for surface soil. Therefore, aluminum concentrations in LWOEU surface soil are unlikely to result in risk concerns for wildlife populations.

4.1.6 Conclusion

The weight of evidence presented above shows that aluminum concentrations in LWOEU surface soil (non-PMJM receptors) are not likely to be a result of historical site-related activities based on process knowledge; a spatial distribution that suggests aluminum is naturally occurring; a probability plot that suggests the presence of a single population, which is also indicative of background conditions; LWOEU concentrations that are well within regional background levels; and LWOEU concentrations that are unlikely to result in risk concerns for wildlife populations. Aluminum is not considered an ECOPC in surface soil for the LWOEU, and therefore, is not further evaluated quantitatively.

4.2 Antimony

Antimony has an EPC in surface soil (for non-PMJM receptors) and subsurface soil greater than the limiting tESL and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if antimony should be retained for risk characterization are summarized below.

4.2.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates antimony may be present in LWOEU soil as a result of historical site-related activities.

4.2.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that antimony concentrations in LWOEU surface soil reflect variations in naturally occurring antimony.

Subsurface Soil

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that antimony concentrations in LWOEU subsurface soil reflect variations in naturally occurring antimony.

4.2.3 Pattern Recognition

Surface Soil

The probability plot for antimony in surface soil (Figure A3.4.2) suggests the presence of a single population, which is indicative of background conditions.

Subsurface Soil

The probability plot for antimony in subsurface soil (Figure A3.4.3) suggests the presence of a single population, which is indicative of background conditions.

4.2.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil

Antimony concentrations in LWOEU surface soil range from 0.300 to 9.80 mg/kg, with a mean concentration of 1.48 mg/kg and a standard deviation of 2.39 mg/kg (Table A3.2.6). None of the background antimony sample results were detects. Detection limits varied from 0.25 to 0.33 mg/kg.

Most of the antimony concentrations in LWOEU surface soils are within the range for antimony in soils of Colorado and the bordering states (less than 1.038 to 2.531 mg/kg, with a mean concentration of 0.647 mg/kg and a standard deviation of 0.378 mg/kg) (Table A3.4.1). There is only one detected antimony concentration (9.8 mg/kg) in the LWOEU that is above this range.

Subsurface Soil

Antimony concentrations in LWOEU subsurface soil range from 0.30 to 20.2 mg/kg, with a mean concentration of 2.44 mg/kg and a standard deviation of 4.07 mg/kg. Antimony concentrations in the background data set range from 2.90 to 8.20 mg/kg, with a mean concentration of 4.21 mg/kg and a standard deviation of 2.78 mg/kg (Table A3.2.10).

4.2.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The UTL for antimony in the LWOEU (6.55 mg/kg) exceeds the NOAEL ESLs for three non-PMJM receptors: terrestrial plants (5 mg/kg), deer mouse herbivore (0.90 mg/kg), and coyote insectivore (3.85 mg/kg). Antimony was detected only one time above the range of Colorado and bordering states background concentrations in an area unassociated with potential historical sources, indicating that antimony concentrations are due to local variations.

Subsurface Soil

The MDC for antimony in LWOEU (20.2 mg/kg) subsurface soil exceeds the NOAEL ESL for the prairie dog (18.7 mg/kg).

4.2.6 Conclusion

The weight of evidence presented above shows that antimony concentrations in LWOEU surface soil (non-PMJM receptors) and subsurface soil could be related to historical site-related activities based on process knowledge; a spatial distribution that suggests antimony is naturally occurring; a probability plot that suggests the presence of a single population which is also indicative of background conditions; a single LWOEU concentration that was above the background concentration range; and the MDC for antimony in subsurface soil only slightly exceeded the prairie dog ESL. Antimony is not considered an ECOPC in surface soil or subsurface soil for the LWOEU and, therefore, is not further evaluated quantitatively.

4.3 Arsenic

Arsenic has concentrations statistically greater than background in surface soil/surface sediment and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if arsenic should be retained for risk characterization are summarized below.

4.3.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates arsenic is unlikely to be present in LWOEU soil as a result of historical site-related activities.

4.3.2 Evaluation of Spatial Trends

Surface Soil/Surface Sediment

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that arsenic concentrations in LWOEU surface soil/surface sediment reflect variations in naturally occurring arsenic.

4.3.3 Pattern Recognition

Surface Soil/Surface Sediment

The probability plot for arsenic in surface soil (Figure A3.4.4) suggests the presence of a single population, which is indicative of background conditions.

4.3.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil/Surface Sediment

Arsenic concentrations in LWOEU surface soil/surface sediment range from 1.50 to 9.80 mg/kg, with a mean concentration of 5.53 mg/kg and a standard deviation of 1.79 mg/kg. Arsenic concentrations in the background data set range from 0.27 to 9.6 mg/kg, with a mean concentration of 3.42 mg/kg and a standard deviation of 2.55 mg/kg (Table A3.2.2).

Arsenic concentrations in LWOEU surface soil/surface sediment are well within the range for arsenic in soils of Colorado and the bordering states (1.22 to 97 mg/kg, with a mean concentration of 6.9 mg/kg and a standard deviation of 7.64 mg/kg) (Table A3.4.1).

4.3.5 Risk Potential for HHRA

Surface Soil/Surface Sediment

The arsenic MDC for surface soil/surface sediment is 9.8 mg/kg and the UCL is 6.10 mg/kg. The UCL is less than three times greater than the PRG (2.41 mg/kg), with 94 of the 96 detections greater than the PRG. Because the PRG is based on an excess carcinogenic risk of 1E-06, the cancer risk based on the UCL concentration is less than 3E-06, and is well within the National Contingency Plan (NCP) risk range of 1E-06 to 1E-04. Arsenic was detected in 67 of 73 background samples, and detected concentrations in 39 of the 67 samples exceeded the PRG. The background UCL for arsenic in surface soil/surface sediment is 4.03 mg/kg (Appendix A, Volume 2, Attachment 9 of the RI/FS Report), which equates to a cancer risk of 2E-06. Therefore, the excess cancer risks to the WRW from exposure to arsenic in surface soil/surface sediment in the LWOEU is similar to background risk.

4.3.6 Conclusion

The weight of evidence presented above shows that arsenic concentrations in LWOEU surface soil/surface sediment are not likely to be a result of historical site-related activities based on process knowledge; spatial distributions that suggest arsenic is naturally occurring; probability plots that suggest the presence of a single arsenic data population, which is also indicative of background conditions; LWOEU concentrations that are well within regional background levels; and LWOEU concentrations that are unlikely to result in risks to humans that are significantly above background. Arsenic is not considered a COC in surface soil/surface sediment for the LWOEU and, therefore, is not further evaluated quantitatively.

4.4 Boron

Boron has an EPC in surface soil (for non-PMJM receptors) greater than the limiting tESL and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if boron should be retained for risk characterization are summarized below.

4.4.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates boron is unlikely to be present in RFETS soil as a result of historical site-related activities.

4.4.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that boron concentrations in LWOEU surface soil reflect variations in naturally occurring boron.

4.4.3 Pattern Recognition

Surface Soil (Non-PMJM)

The probability plot of boron concentrations in surface soil in the LWOEU shows the presence of a single population, which is indicative of background conditions (Figure A3.4.5).

4.4.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

The reported range for boron in surface soils within Colorado and the bordering states is 20 to 150 mg/kg, with a mean of 27.9 mg/kg and a standard deviation of 19.7 mg/kg (Table A3.4.1). Boron concentrations reported in surface soil samples at the LWOEU range from 2.3 to 13.0 mg/kg, with a mean concentration of 7.00 mg/kg and a standard deviation of 2.08 mg/kg (Table A3.2.6). The range of concentrations of boron in surface soil is well within the range for boron in soils of Colorado and bordering states (20 to 150 mg/kg).

4.4.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The UTL for boron in the LWOEU (10.5 mg/kg) exceeds the NOAEL ESL for only one receptor group, terrestrial plants (0.5 mg/kg). All other NOAEL ESLs were greater than the UTL and ranged from 30 to 6,070 mg/kg. Site-specific background data for boron were not available but the MDC did not exceed the low end (20 mg/kg) of the background range presented in Shacklette and Boerngen (1984). This indicates the terrestrial plant NOAEL ESL (0.5 mg/kg) is well below expected background concentrations, and because risks are not typically expected at background concentrations, boron concentrations are not likely to be indicative of site-related risk to the terrestrial plant community in the LWOEU. Kabata-Pendias and Pendias (1992) indicate soil with boron concentrations equal to 0.3 mg/kg is critically deficient in boron, and effects on plant reproduction would be expected. Additionally, the summary of boron toxicity in Efroymson et al. (1997) notes that the source of the 0.5 mg/kg NOAEL ESL indicates boron was toxic when added at 0.5 mg/kg to soil, but gives no indication of the boron concentration in the baseline soil before addition. The confidence placed by Efroymson et al. (1997) was low. Because no NOAEL ESLs, other than the terrestrial plant NOAEL ESL, are exceeded by the MDC, boron is unlikely to present a risk to terrestrial receptor populations in the LWOEU.

4.4.6 Conclusion

The weight of evidence presented above shows that boron concentrations in LWOEU surface soil (non-PMJM receptors) are not likely to be a result of historical site-related activities based on process knowledge; a spatial distribution that suggests boron is naturally occurring; a probability plot that suggests the presence of a single population, which is also indicative of background conditions; LWOEU concentrations that are well within regional background levels; and LWOEU concentrations that are unlikely to result in risk concerns for wildlife populations. Boron is not considered an ECOPC in surface soil for the LWOEU and, therefore, is not further evaluated quantitatively.

4.5 Chromium

Chromium had an EPC in surface soil (for non-PMJM receptors) greater than the tESL and, therefore, was carried forward to the professional judgment step. In addition, chromium in surface soil (for PMJM receptors) had concentrations statistically greater than background and, therefore, was carried forward to the professional judgment step. The lines of evidence that were used to determine if chromium should be retained as a COC are summarized below.

4.5.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates a potential for chromium to have been released into RFETS soil because of the moderate chromium metal inventory and presence of chromium in waste generated during former operations. Spills of chromium have occurred at RFETS. However, the historical sources of chromium are remote from the LWOEU. Therefore, chromium is unlikely to be present in LWOEU soil as a result of historical site-related activities.

4.5.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend indicates that elevated chromium concentrations in LWOEU surface soil (non-PMJM) are located within or near historical IHSSs and, therefore, could not be eliminated as an ECOPC.

184

Surface Soil (PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that chromium concentrations in LWOEU surface soil (PMJM) appear to have a spatial concentration trend.

4.5.3 Conclusion

Chromium in surface soil is being carried forward into the ecological non-PMJM risk characterization because elevated concentrations (greater than background MDC, less than three times background MDC) are within or near historical Individual Hazardous Substance Sites (IHSSs). Chromium was used in limited quantities during historical RFETS operations, which would indicate it is unlikely to be a site-related contaminant. Nevertheless, as a conservative measure, chromium is carried forward into the risk characterization, recognizing that its classification as a COC/ECOPC is uncertain.

Chromium in surface soil concentrations is being carried forward into the ecological PMJM risk characterization because elevated concentrations (greater than the ESL) are within one or more PMJM habitat patches. Due to the exceedances in the PMJM habitat patches, chromium is retained as an ECOPC for further evaluation in the risk characterization.

4.6 Copper

Copper had an EPC in surface soil (for non-PMJM receptors) greater than the tESL and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if copper should be retained as a COC are summarized below.

4.6.1 Summary of Process Knowledge

Based on process knowledge as detailed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, copper may be present in RFETS soil as a result of historical site-related activities.

4.6.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

Based on the spatial trend evaluation detailed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, elevated copper concentrations in the LWOEU were located near historical IHSS, therefore copper could not be eliminated as an EPCOC.

Surface Soil (PMJM)

Based on the spatial trend evaluation detailed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, elevated copper concentrations in the PMJM habitat in LWOEU were located near historical IHSS, therefore copper could not be eliminated as an EPCOC.

4.6.3 Conclusion

Copper in surface soil is being carried forward into the ecological non-PMJM risk characterization because elevated concentrations (greater than 10 times the MDC) are within or near historical IHSSs. Copper may be a site-related contaminant as a result of historical site-related activities. As a conservative measure, copper is carried forward into the risk characterization, recognizing that its classification as a COC/ECOPC is uncertain.

Copper in surface soil is being carried forward into the ecological PMJM risk characterization because one elevated concentration (greater than the PMJM ESL) is within one PMJM habitat patch. Due to the exceedances in the PMJM habitat patch, copper is retained as an ECOPC for further evaluation in the risk characterization.

4.7 Lithium

Lithium has an EPC in surface soil (for non-PMJM receptors) greater than the limiting tESL and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if lithium should be retained for risk characterization are summarized below.

4.7.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates a potential for lithium to have been released into RFETS soil because of the moderate lithium metal inventory and presence of lithium in waste generated during former operations. However, these historical sources are remote from the LWOEU. Therefore lithium is unlikely to be present in LWOEU soil as a result of historical site-related activities.

4.7.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that lithium concentrations in LWOEU surface soil reflect variations in naturally occurring lithium.

4.7.3 Pattern Recognition

Surface Soil (Non-PMJM)

The probability plot of lithium concentrations in surface soil in the LWOEU shows the presence of a single population (Figure A3.4.6), which is indicative of background conditions.

4.7.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

Lithium concentrations in surface soil samples at the LWOEU range from 1.80 to 22.0 mg/kg, with a mean concentration of 12.5 and a standard deviation of 4.60 mg/kg. Lithium concentrations in the background data set range from 4.80 to 11.6 mg/kg, with a mean of 7.66 mg/kg and a standard deviation of 1.89 mg/kg (Table A3.2.6).

Lithium concentrations reported in surface soils samples at the LWOEU are well within the range for lithium in soils of Colorado and the bordering states (5 to 130 mg/kg, with a mean concentration of 25.3 mg/kg and a standard deviation of 14.4 mg/kg) (Table A3.4.1).

4.7.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The UTL for lithium in the LWOEU (19.9 mg/kg) exceeds the NOAEL ESL for only one receptor group, terrestrial plants (2 mg/kg). All other NOAEL ESLs were greater than the UTL and ranged from 610 to 18,431 mg/kg. The ESL for terrestrial plants is lower than all detected background concentrations. Because risks to ecological receptors are not expected at background concentrations, the terrestrial plant ESL may be overly-conservative.

4.7.6 Conclusion

The weight of evidence presented above shows that lithium concentrations in LWOEU surface soil (non-PMJM receptors) are not likely to be a result of historical site-related activities based on process knowledge; a spatial distribution indicative of naturally occurring lithium; a probability plot that suggests the presence of a single population, which is also indicative of background conditions; and LWOEU concentrations that are well within regional background levels. Lithium is not considered an ECOPC in surface soil for the LWOEU and, therefore, is not further evaluated quantitatively.

4.8 Manganese

Manganese has concentrations statistically greater than background in surface soil/surface sediment, has an EPC in surface soil (for non-PMJM receptors) greater than the tESL, and has concentrations statistically greater than background in surface soil (for PMJM receptor). Therefore, manganese in surface soil/surface sediment and surface soil (non-PMJM and PMJM receptors) was carried forward to the professional judgment step. The lines of evidence used to determine if manganese should be retained for risk characterization are summarized below.

4.8.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates manganese is unlikely to be present in RFETS soil as a result of historical site-related activities.

4.8.2 Evaluation of Spatial Trends

Surface Soil/Surface Sediment

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that manganese concentrations in LWOEU surface soil/surface sediment reflect variations in naturally occurring manganese.

Surface Soil (Non-PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that elevated manganese concentrations in LWOEU surface soil (non-PMJM) were located near historical IHSSs and therefore cannot be eliminated as an ECOPC.

Surface Soil (PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that elevated manganese concentrations in LWOEU surface soil (PMJM) were located near historical IHSSs and therefore cannot be eliminated as an ECOPC.

4.8.3 Pattern Recognition

Surface Soil/Surface Sediment

The probability plot for manganese concentrations suggests a single population, which indicates background conditions (Figure A3.4.7).

4.8.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil/Surface Sediment

Manganese concentrations in surface soil/surface sediment samples at the LWOEU range from 106 to 1,580 mg/kg, with a mean concentration of 383 mg/kg and a standard deviation of 207 mg/kg. Manganese concentrations in the background data set range from 9.00 to 1,280 mg/kg, with a mean concentration of 241 mg/kg and a standard deviation of 189 mg/kg (Table A3.2.2).

4.8.5 Risk Potential for HHRA

Surface Soil/Surface Sediment

The manganese UCL for surface soil/surface sediment is 422 mg/kg. The UCL is slightly greater than the PRG (419 mg/kg), with one of the 97 detections greater than the PRG. Because the PRG is based on a hazard quotient of 0.1, the hazard quotient for manganese in the LWOEU is well below EPA's guideline of an HQ of 1.

4.8.6 Conclusion

The weight of evidence presented above shows that manganese concentrations in the LWOEU surface soil/surface sediment are not likely to be a result of historical site-related activities based on process knowledge; spatial distributions that suggest manganese is naturally occurring; probability plots that suggest the presence of single populations, which are also indicative of background conditions; and LWOEU concentrations that are unlikely to result in risks to humans. Manganese is not considered a COC in surface soil/surface sediment for the LWOEU.

Manganese in surface soil is being carried forward into the ecological non-PMJM risk characterization because elevated concentrations (greater than three times the ESL) are within or near historical IHSSs.

Manganese in surface soil is being carried forward into the ecological PMJM risk characterization because elevated concentrations (more than three times greater than the ESL) are within one or more PMJM habitat patches.

4.9 Nickel

Nickel has an EPC in surface soil (for non-PMJM receptors) greater than the tESL, and concentrations statistically greater than background in surface soil (for the PMJM

186

receptor) and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if nickel should be retained for risk characterization are summarized below.

4.9.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates a potential for nickel to have been released into RFETS soil because of the moderate nickel metal inventory and presence of nickel in waste generated during former operations. Therefore nickel may be present in LWOEU soil as a result of historical site-related activities.

4.9.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that elevated nickel concentrations in LWOEU surface soil are located near historical IHSSs and therefore cannot be eliminated as an ECOPC.

Surface Soil (PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that elevated nickel concentrations in LWOEU surface soil in PMJM habitat are located near historical IHSSs and therefore cannot be eliminated as an ECOPC.

4.9.3 Conclusion

Nickel in surface soil is being carried forward into the ecological non-PMJM risk characterization because elevated concentrations (greater than 10 times the ESL) are within or near historical IHSSs.

Nickel in surface soil is being carried forward into the ecological PMJM risk characterization because elevated concentrations (more than three times greater than the ESL) are within one or more PMJM habitat patches. Nickel is also used at RFETS and/or identified in wastes, although uses and releases in the LWOEU have not been identified.

4.10 Radium-228

Radium-228 has activities that are statistically greater than background in surface soil/surface sediment and was carried forward to the professional judgment step. The lines of evidence used to determine if radium-228 should be retained for risk characterization are summarized below.

4.10.1 Summary of Process Knowledge

The ChemRisk Task 1 Report did not identify radium-228 as a radionuclide used at RFETS (CDH 1991), and no radium-228 waste was reported to have been generated. It is unlikely that radium-228 is present in soil at RFETS as a result of historical site-related activities.

4.10.2 Evaluation of Spatial Trends

Surface Soil/Surface Sediment

As shown in Figure A3.4.8, radium-228 activities exceed the PRG of 0.111 picocuries per gram (pCi/g) at locations throughout the LWOEU. There are no locations where the radium-228 activity exceeds the background MDC. None of these locations are near historical IHSSs. Thus it appears that radium-228 activities in LWOEU surface soil reflect variations in naturally occurring radium-228.

4.10.3 Pattern Recognition

Surface Soil/Surface Sediment

The probability plot for radium-228 activities suggests a single population which is indicative of background conditions (Figure A3.4.9).

4.10.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil/Surface Sediment

Radium-228 activities in surface soil/surface sediment samples at the LWOEU range from 1.19 to 2.80 pCi/g, with a mean activity of 1.94 pCi/g and a standard deviation of 0.519 pCi/g. The radium-228 activities in the background data set range from 0.200 to 4.10 pCi/g, with a mean activity of 1.60 pCi/g and a standard deviation of 0.799 pCi/g (Table A3.2.2). The range of activities of radium-228 in the LWOEU and background samples considerably overlap and the means are similar. Furthermore, radium-228 detections in LWOEU surface soil/surface sediment are all below the background MDC.

4.10.5 Risk Potential for HHRA

The radium-228 UCL for surface soil/surface sediment is 2.26 pCi/g. The PRG is 0.111 pCi/g, with all of the detections greater than the PRG. Because the PRG is based on an excess carcinogenic risk of 1E-06, the cancer risk based on the UCL activity is less than 2E-05 and is well within the NCP risk range of 1E-06 to 1E-04. Because the radium-228 activities appear to be naturally occurring, the excess cancer risks to the WRW from exposure to radium-228 in surface soil/surface sediment in the LWOEU is similar to background risk.

4.10.6 Conclusion

The weight of evidence presented above shows that radium-228 activities in LWOEU surface soil/surface sediment are not likely to be a result of historical site-related activities based on process knowledge; a spatial distribution indicative of naturally occurring radium-228; a probability plot that suggests the presence of a single population, which is also indicative of background conditions; and LWOEU radium-228 activities that are unlikely to result in risks to humans significantly above background risks. Radium-228 is not considered a COC in surface soil/surface sediment for the LWOEU and, therefore, is not further evaluated quantitatively.

4.11 Selenium

Selenium had concentrations statistically greater than background in surface soil (for PMJM receptors) and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if selenium should be retained as a COC are summarized below.

4.11.1 Summary of Process Knowledge

Based on process knowledge as detailed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the potential for selenium to be an ECOPC in the LWOEU is low due to small inventory, used as a laboratory standard only; limited identification as a constituent in wastes generated at RFETS; and localized documented historical source areas remote from the LWOEU.

4.11.2 Evaluation of Spatial Trends

Surface Soil (PMJM)

Based on the spatial trend evaluation detailed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, elevated selenium concentrations in the LWOEU surface soil are located near historical IHSSs and therefore cannot be eliminated as an ECOPC.

4.11.3 Conclusion

Although process knowledge indicates selenium should not be present in the LWOEU surface soil, selenium is being carried forward into the ecological PMJM risk characterization as a conservative measure because the concentrations above background were located near historical IHSSs.

4.12 Thallium

Thallium has an EPC in surface soil (for non-PMJM receptors) greater than the limiting tESL and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if thallium should be retained for risk characterization are summarized below.

4.12.1 Summary of Process Knowledge

Based on process knowledge as detailed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the potential for thallium to be an ECOPC in the LWOEU is low due to small inventory, used as a laboratory standard only; limited identification as a constituent in wastes generated at RFETS; and localized documented historical source areas remote from the LWOEU.

4.12.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

Based on the spatial trend evaluation detailed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, elevated thallium concentrations in the LWOEU surface soil are located near historical IHSSs and therefore cannot be eliminated as an ECOPC.

4.12.3 Conclusion

Thallium in surface soil is being carried forward into the ecological PMJM risk characterization because elevated concentrations (more than three times greater than the ESL) are located within or near historical IHSSs. Thallium was used at RFETS and identified in wastes, although uses and releases in the LWOEU have not been identified.

4.13 Tin

Tin has an EPC in surface soil (for non-PMJM receptors) greater than the limiting tESL and, therefore, was carried forward to the professional judgment step. In addition, tin in surface soil (for PMJM receptors) has concentrations statistically greater than background and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if tin should be retained for risk characterization are summarized below.

4.13.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates a potential for tin to have been released into RFETS soil because of the moderate tin metal inventory during former operations. Therefore, tin may be present in LWOEU soil as a result of historical site-related activities.

4.13.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

Based on the spatial trend evaluation detailed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, elevated tin concentrations in the LWOEU are located near historical IHSSs and therefore cannot be eliminated as an ECOPC.

Surface Soil (PMJM)

Based on the spatial trend evaluation detailed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, elevated tin concentrations in the LWOEU are located near historical IHSSs and therefore cannot be eliminated as an ECOPC.

4.13.3 Conclusion

Tin in surface soil is being carried forward into the ecological non-PMJM risk characterization because elevated concentrations (greater than 10 times the ESL) within or near historical IHSSs. Tin was also used at RFETS and identified in wastes, although uses and releases in the LWOEU have not been identified.

Tin in surface soil is being carried forward into the ecological PMJM risk characterization because elevated concentrations (more than three times greater than the ESL) are within one or more PMJM habitat patches. Tin was also used at RFETS and identified in wastes, although uses and releases in the LWOEU have not been identified.

4.14 Vanadium

Vanadium has an EPC in surface soil (for non-PMJM receptors) greater than the tESL so was carried forward to the professional judgment step. In addition, vanadium in surface soil (for PMJM receptors) and subsurface soils had concentrations statistically greater than background and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if vanadium should be retained as a COC are summarized below.

4.14.1 Summary of Process Knowledge

Based on process knowledge as detailed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the potential for vanadium to be a COC in the LWOEU is low due to small inventory, used as a laboratory standard only, limited identification as a constituent in wastes generated at RFETS and localized documented historical source areas remote from the LWOEU. Based on process knowledge, vanadium is unlikely to be present in LWOEU soil as a result of historical site-related activities.

4.14.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

Based on the spatial trend evaluation detailed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, elevated vanadium concentrations in the LWOEU are located near historical IHSSs and therefore cannot be eliminated as an ECOPC.

Surface Soil (PMJM)

Based on the spatial trend evaluation detailed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, elevated vanadium concentrations in the LWOEU are located near historical IHSSs and therefore cannot be eliminated as an ECOPC.

4.14.3 Conclusion

Vanadium in surface soil concentrations is being carried forward into the ecological non-PMJM risk characterization because elevated concentrations (greater than 10 times the ESL) are within an historical PAC. Vanadium was used in limited quantities during historical RFETS operations, which would indicate it is unlikely to be site-related contaminants. Nevertheless, as a conservative measure, it is carried forward into the risk characterization recognizing that its classification as an ECOPC is uncertain.

Vanadium in surface soil concentrations is being carried forward into the ecological PMJM risk characterization because elevated concentrations (more than three times greater than the ESL) are within one or more PMJM habitat patches. Vanadium is unlikely to be an ECOPC at the LWNEU based on low metal inventories at RFETS, use as a laboratory standard only, and/or limited identification as a constituent in wastes generated at RFETS. However, due to the exceedances in the PMJM habitat patches, vanadium is retained as an ECOPC for further evaluation in the risk characterization.

4.15 Zinc

Zinc has an EPC in surface soil (for non-PMJM receptors) greater than the limiting tESL and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if zinc should be retained for risk characterization are summarized below.

4.15.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates a potential for zinc to have been released into RFETS soil because of the moderate zinc metal inventory and the presence of zinc in waste generated during former operations. However, there are no IHSSs in the LWOEU. Therefore, zinc is unlikely to be present in LWOEU soil as a result of historical site-related activities.

4.15.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that zinc concentrations in LWOEU surface soil reflect variations in naturally occurring zinc.

Surface Soil (PMJM)

Based on the spatial trend evaluation detailed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, elevated zinc concentrations in the LWOEU on PMJM patches are located near historical IHSSs and therefore cannot be eliminated as an ECOPC.

4.15.3 Pattern Recognition

Surface Soil (Non-PMJM)

The probability plot of zinc concentrations in surface soil in the LWOEU shows the presence of a single population (Figure A3.4.10), which is indicative of background conditions.

4.15.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

Zinc concentrations in surface soil samples at the LWOEU range from 17.9 to 86.1 mg/kg, with a mean concentration of 56.7 mg/kg and a standard deviation of 13.4 mg/kg. Zinc concentrations in the background data set range from 21.1 to 75.9 mg/kg, with a mean concentration of 49.8 mg/kg and a standard deviation of 12.2 mg/kg (Table A3.2.4). The range of concentrations of zinc in the LWOEU and background samples overlap and the means are similar.

The reported range for zinc in surface soils within Colorado and the bordering states is 10 mg/kg to 2,080 mg/kg, with an arithmetic mean of 72.4 mg/kg and a standard deviation of 159 mg/kg (Table A3.4.1). The range of concentrations of zinc in surface soil is within the range for zinc in soils of Colorado and the bordering states.

4.15.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The UTL for zinc in the LWOEU (77.7 mg/kg) exceeds the NOAEL ESLs for three receptor groups: terrestrial plants (50 mg/kg), mourning dove insectivore (0.65 mg/kg), and deer mouse insectivore (5.29 mg/kg). All other NOAEL ESLs were greater than the UTL and ranged from 109 to more than 16,489 mg/kg. The mourning dove and deer mouse (insectivore) ESLs are both considerably lower than all zinc concentrations in background soils. Because risks are not typically expected at background concentrations, it is likely that these ESLs are overly conservative. The terrestrial plant ESL is approximately equal to the median background concentration, again indicating that it may be overly conservative for use in the risk assessment.

4.15.6 Conclusion

The weight of evidence presented above shows that zinc concentrations in LWOEU surface soil (non-PMJM receptors) are not likely to be a result of historical site-related activities based on process knowledge; a spatial distribution indicative of naturally occurring zinc; a probability plot that suggests the presence of a single population, which is also indicative of background conditions; and LWOEU concentrations that are well within regional background levels. Zinc is not considered an ECOPC in surface soil for the LWOEU and, therefore, is not further evaluated quantitatively.

Zinc is being carried forward into the ecological PMJM risk characterization because elevated concentrations (more than three times greater than the ESL) are within one or more PMJM habitat patches. Zinc was also used at RFETS and/or identified in wastes, although uses and releases in the LWOEU have not been identified.

5.0 REFERENCES

Colorado Department of Health (CDH), 1991. Colorado Department of Health Project Task 2 Selection of the Chemicals and Radionuclides of Concern. Prepared by ChemRisk. June.

DOE, 2004a. Final Comprehensive Risk Assessment Work Plan and Methodology, Rocky Flats Environmental Technology Site, Golden, Colorado. Revision 1. September.

Efroymson, R.A., M.E. Will, G.W. Suter II, and A.C. Wooten, 1997. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants. 1997 Revision, ES/ER/TM-85/R3. Oak Ridge National Laboratory, Oak Ridge, Tennessee.

EPA, 2003. Guidance for Developing Ecological Soil Screening Levels (Eco-SSLs). OSWER 9285.7-55. Office of Solid Waste and Emergency Response. December.

EPA, 2005. Guidance for Developing Ecological Soil Screening Levels (Eco-SSLs). Attachment 4-1 Update. Office of Solid Waste and Emergency Response, February.

Kabata-Pendias, A., and H. Pendias, 1992. Trace Elements in Soils and Plants. Second Edition. CRC Press, Boca Raton, Florida. 365 pp

Shacklette, H.T., and J.G. Boerngen, 1984. Element Concentrations in Soils and Other Surface Materials of the Contiguous United States. Professional Paper 1270. U.S. Geological Survey, Washington, D.C.

TABLES

Table A3.2.1
Statistical Distributions and Comparison to Background for LWOEU Surface Soil/Surface Sediment

Analyte	Units	Statistical Distribution Testing Results						Background Comparison Test Results		
		Background Data Set			LWOEU Data Set[a]					
		Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Test	1 - p	Statistically Greater than Background?
Arsenic	**mg/kg**	**73**	**GAMMA**	**92**	**97**	**NORMAL**	**100**	**WRS**	**5.35E-09**	**Yes**
Manganese	**mg/kg**	**73**	**GAMMA**	**100**	**97**	**NON-PARAMETRIC**	**100**	**WRS**	**1.65E-11**	**Yes**
Cesium-134	pCi/g	77	NONPARAMETRIC	N/A	13	NORMAL	N/A	WRS	0.994	No
Cesium-137	pCi/g	105	NONPARAMETRIC	N/A	19	GAMMA	N/A	WRS	0.995	No
Radium-228	**pCi/g**	**40**	**GAMMA**	**N/A**	**9**	**NORMAL**	**N/A**	**WRS**	**0.048**	**Yes**

[a] LWOEU data exclude background data.

WRS = Wilcoxon Rank Sum

N/A = Not applicable; all radionuclide values are considered detect.

Bold = Analyte retained for further consideration in the next COC selection step.

192

Table A3.2.2

Summary Statistics for Background and LWOEU Surface Soil/Surface Sediment[a]

Analyte	Units	Background					LWOEU[b]				
		Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Detected Concentration	Standard Deviation	Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Detected Concentration	Standard Deviation
Arsenic	mg/kg	73	0.270	9.60	3.42	2.55	97	1.50	9.80	5.53	1.79
Manganese	mg/kg	73	9.00	1,280	241	189	97	106	1,580	383	207
Cesium-134	pCi/g	77	1.00E-03	0.300	0.141	0.066	13	0.002	0.200	0.085	0.052
Cesium-137	pCi/g	105	-0.027	1.80	0.692	0.492	19	0.039	1.18	0.349	0.315
Radium-228	pCi/g	40	0.200	4.10	1.60	0.799	9	1.19	2.80	1.94	0.519

[a] For inorganics and organics, statistics are computed using one-half the reported value for nondetects.

[b] LWOEU data exclude background data.

103

Table A3.2.3
Statistical Distributions and Comparison to Background for LWOEU Subsurface Soil/Subsurface Sediment

Analyte	Statistical Distribution Testing Results						Background Comparison Test Results		
	Background Data Set			LWOEU Data Set [a]					
	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Test	1 - p	Statistically Greater than Background?
Radium-228	31	GAMMA	N/A	5	NORMAL	N/A	WRS	0.912	No

[a] LWOEU data exclude background data.

WRS = Wilcoxon Rank Sum

N/A = Not applicable; all radionuclide values are considered detect.

194

Table A3.2.4

Summary Statistics for Background and LWOEU Subsurface Soil/Subsurface Sediment[a]

		Background					LWOEU[b]				
Analyte	Units	Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Detected Concentration	Standard Deviation	Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Detected Concentration	Standard Deviation
Radium-228	pCi/g	31	1.00	2.10	1.45	0.320	5	1.07	1.57	1.27	0.198

[a] For inorganics and organics, statistics are computed using one-half the reported value for nondetects.

[b] LWOEU data exclude background data.

195

Table A3.2.5
Statistical Distributions and Comparison to Background for LWOEU Surface Soil

Analyte	Statistical Distribution Testing Results						Background Comparison Test Results		
	Background Data Set			LWOEU Data Set [a]					
	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Test	1 - p	Statiscally Greater than Background?
Aluminum	**20**	**NORMAL**	**100**	**74**	**NORMAL**	**100**	**t-Test_N**	**6.51E-04**	**Yes**
Antimony	**20**	**NONPARAMETRIC**	**0**	**60**	**NONPARAMETRIC**	**47**	**N/A**	**N/A**	**N/A**
Arsenic	20	NORMAL	100	74	NONPARAMETRIC	100	WRS	0.611	No
Barium	**20**	**NORMAL**	**100**	**74**	**NORMAL**	**100**	**t-Test_N**	**1.24E-05**	**Yes**
Boron	**N/A**	**N/A**	**N/A**	**46**	**NORMAL**	**93**	**N/A**	**N/A**	**N/A**
Cadmium	20	NONPARAMETRIC	65	73	GAMMA	60	WRS	1.000	No
Chromium	**20**	**NORMAL**	**100**	**74**	**NORMAL**	**100**	**t-Test_N**	**8.71E-05**	**Yes**
Cobalt	20	NORMAL	100	74	NONPARAMETRIC	100	WRS	0.120	No
Copper	**20**	**NONPARAMETRIC**	**100**	**74**	**NONPARAMETRIC**	**100**	**WRS**	**4.42E-05**	**Yes**
Lead	20	NORMAL	100	74	NONPARAMETRIC	100	WRS	0.389	No
Lithium	**20**	**NORMAL**	**100**	**58**	**NORMAL**	**95**	**t-Test_N**	**1.13E-05**	**Yes**
Manganese	**20**	**NORMAL**	**100**	**74**	**NONPARAMETRIC**	**100**	**WRS**	**4.69E-07**	**Yes**
Mercury	20	NONPARAMETRIC	40	58	NONPARAMETRIC	60	WRS	1.000	No
Nickel	**20**	**NORMAL**	**100**	**74**	**GAMMA**	**97**	**WRS**	**6.22E-07**	**Yes**
Selenium	20	NONPARAMETRIC	60	74	NONPARAMETRIC	27	WRS	0.982	No
Thallium	**14**	**NORMAL**	**0**	**74**	**NONPARAMETRIC**	**47**	**N/A**	**N/A**	**N/A**
Tin	**20**	**NORMAL**	**0**	**60**	**NONPARAMETRIC**	**18**	**N/A**	**N/A**	**N/A**
Vanadium	**20**	**NORMAL**	**100**	**74**	**NORMAL**	**100**	**t-Test_N**	**4.27E-05**	**Yes**
Zinc	**20**	**NORMAL**	**100**	**74**	**NORMAL**	**100**	**t-Test_N**	**0.020**	**Yes**

[a] LWOEU data exclude background data.
WRS = Wilcoxon Rank Sum
t-Test_N = Student's t-test using normal data
N/A = Not applicable; site and/or background detection frequency less than 20%.
Bold = Analyte retained for further consideration in the next ECOPC selection step.

196

Table A3.2.6
Summary Statistics for Background and LWOEU Surface Soil[a]

Analyte	Units	Background					LWOEU[b]				
		Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Detected Concentration	Standard Deviation	Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Detected Concentration	Standard Deviation
Aluminum	mg/kg	20	4,050	17,100	10,203	3,256	74	3,900	30,000	15,019	6,250
Antimony	mg/kg	20	N/A	N/A	0.279	0.078	60	0.300	9.80	1.48	2.39
Arsenic	mg/kg	20	2.30	9.60	6.09	2.00	74	2.00	8.80	5.84	1.71
Barium	mg/kg	20	45.7	134	102	19.4	74	46.8	240	146	43.0
Boron	mg/kg	N/A	N/A	N/A	N/A	N/A	46	2.30	13.0	7.00	2.08
Cadmium	mg/kg	20	0.670	2.30	0.708	0.455	73	0.110	1.30	0.408	0.238
Chromium	mg/kg	20	5.50	16.9	11.2	2.78	74	4.80	28.0	16.7	6.02
Cobalt	mg/kg	20	3.40	11.2	7.27	1.79	74	3.60	20.2	7.94	2.17
Copper	mg/kg	20	5.20	16.0	13.0	2.58	74	7.60	170	19.0	18.5
Lead	mg/kg	20	8.60	53.3	33.5	10.5	74	6.40	210	48.6	43.3
Lithium	mg/kg	20	4.80	11.6	7.66	1.89	58	1.80	22.0	12.5	4.60
Manganese	mg/kg	20	129	357	237	63.9	74	113	1,200	375	170
Mercury	mg/kg	20	0.090	0.120	0.072	0.031	58	0.013	0.660	0.045	0.084
Nickel	mg/kg	20	3.80	14.0	9.60	2.59	74	7.60	45.2	15.8	5.86
Selenium	mg/kg	20	0.680	1.40	0.628	0.305	74	0.260	2.00	0.444	0.274
Thallium	mg/kg	14	N/A	N/A	0.414	0.015	74	0.250	5.70	0.930	0.936
Tin	mg/kg	20	N/A	N/A	2.06	0.410	60	1.70	85.9	5.16	12.7
Vanadium	mg/kg	20	10.8	45.8	27.7	7.68	74	16.5	71.0	39.4	12.1
Zinc	mg/kg	20	21.1	75.9	49.8	12.2	74	17.9	86.1	56.7	13.4

[a] For inorganics and organics, statistics are computed using one-half the reported value for nondetects.

[b] LWOEU data exclude background data.

N/A = Not applicable; Data are nondetects.

197

Table A3.2.7

Statistical Distributions and Comparison to Background for Surface Soil in PMJM Habitat in the LWOEU

Analyte	Statistical Distribution Testing Results						Background Comparison Test Results		
	Background Data Set			LWOEU Data Set[a]					
	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Test	1 - p	Statistically Greater than Background?
Inorganics									
Arsenic	20	NORMAL	100	45	NON-PARAMETRIC	100.00	WRS	0.120	No
Chromium	**20**	**NORMAL**	**100**	**45**	**NORMAL**	**100.00**	**t-Test_N**	**7.37E-08**	**Yes**
Copper	**20**	**NON-PARAMETRIC**	**100**	**45**	**NON-PARAMETRIC**	**100.00**	**WRS**	**6.34E-06**	**Yes**
Manganese	**20**	**NORMAL**	**100**	**45**	**NON-PARAMETRIC**	**100.00**	**WRS**	**8.04E-09**	**Yes**
Mercury	20	NON-PARAMETRIC	40	42	GAMMA	76.19	WRS	1.000	No
Nickel	**20**	**NORMAL**	**100**	**45**	**GAMMA**	**100.00**	**WRS**	**1.03E-08**	**Yes**
Selenium	**20**	**NON-PARAMETRIC**	**60**	**45**	**NON-PARAMETRIC**	**13.33**	**N/A**	**N/A**	**N/A**
Tin	**20**	**NORMAL**	**0**	**43**	**NON-PARAMETRIC**	**20.93**	**N/A**	**N/A**	**N/A**
Vanadium	**20**	**NORMAL**	**100**	**45**	**NORMAL**	**100.00**	**t-Test_N**	**2.59E-08**	**Yes**
Zinc	**20**	**NORMAL**	**100**	**45**	**NORMAL**	**100.00**	**t-Test_N**	**0.007**	**Yes**

[a] LWOEU data exclude background data.

WRS = Wilcoxon Rank Sum

t-Test_N = Student's t-test using normal data

N/A = Not applicable; site and/or background detection frequency less than 20%.

Bold = Analyte retained for further consideration in the next ECOPC selection step.

198

Table A3.2.8

Summary Statistics for Background and LWOEU Surface Soil in PMJM Habitat[a]

Analyte	Units	Background					LWOEU[b]				
		Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Detected Concentration	Standard Deviation	Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Detected Concentration	Standard Deviation
Arsenic	mg/kg	20	2.30	9.60	6.09	2.00	45	3.20	8.80	6.53	1.38
Chromium	mg/kg	20	5.50	16.9	11.2	2.78	45	7.20	28.0	18.8	5.41
Copper	mg/kg	20	5.20	16.0	13.0	2.58	45	7.60	170	20.9	23.3
Manganese	mg/kg	20	129	357	237	63.9	45	270	1,200	418	191
Mercury	mg/kg	20	0.090	0.120	0.072	0.031	42	0.013	0.059	0.033	0.014
Nickel	mg/kg	20	3.80	14.0	9.60	2.59	45	8.10	45.2	17.3	5.65
Selenium	mg/kg	20	0.680	1.40	0.628	0.305	45	0.280	2.00	0.495	0.283
Tin	mg/kg	20	N/A	N/A	2.06	0.410	43	1.70	32.7	2.88	6.10
Vanadium	mg/kg	20	10.8	45.8	27.7	7.68	45	20.0	59.0	42.4	9.29
Zinc	mg/kg	20	21.1	75.9	49.8	12.2	45	19.0	86.1	58.4	12.8

[a] For inorganics and organics, statistics are computed using one-half the reported value for nondetects.

[b] LWOEU data exclude background data.

N/A = Not applicable; Data are nondetects.

199

Table A3.2.9
Statistical Distributions and Comparison to Background for LWOEU Subsurface Soil

Analyte	Statistical Distribution Testing Results						Background Comparison Test Results		
	Background Data Set			LWOEU Data Set[a]					
	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Test	1 - p	Statistically Greater than Background?
Antimony	**28**	**NONPARAMETRIC**	**7**	**46**	**NONPARAMETRIC**	**35**	**N/A**	**N/A**	**N/A**
Arsenic	**45**	**NONPARAMETRIC**	**93**	**47**	**NONPARAMETRIC**	**100**	**WRS**	**0.010**	**Yes**
Nickel	44	GAMMA	100	47	NONPARAMETRIC	100	WRS	0.574	No
Vanadium	**45**	**NORMAL**	**98**	**47**	**NONPARAMETRIC**	**100**	**WRS**	**0.002**	**Yes**

[a] LWOEU data exclude background data.

WRS = Wilcoxon Rank Sum
N/A = Not applicable; site and/or background detection frequency less than 20%.

Bold = Analyte retained for further consideration in the next ECOPC selection step.

200

Table A3.2.10

Summary Statistics for Background and LWOEU Subsurface Soil[a]

Analyte	Units	Background					LWOEU[b]				
		Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Detected Concentration	Standard Deviation	Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Detected Concentration	Standard Deviation
Antimony	mg/kg	28	2.90	8.20	4.21	2.78	46	0.300	20.2	2.44	4.07
Arsenic	mg/kg	45	1.70	41.8	5.48	6.02	47	1.60	15.0	5.96	2.59
Nickel	mg/kg	44	4.30	54.2	20.9	11.1	47	5.20	49.9	19.2	7.44
Vanadium	mg/kg	45	11.4	70.0	33.8	14.8	47	14.0	110	44.9	19.1

[a] For inorganics and organics, statistics are computed using one-half the reported value for nondetects.

[b] LWOEU data exclude background data.

Table A3.4.1

Summary of Element Soil Concentrations in Colorado and Bordering States[a]

Analyte	Total Number of Results	Detection Frequency (%)	Range of Detected Values (mg/kg)	Average (mg/kg)[b]	Standard Deviation (mg/kg)[b]
Aluminum	303	100	5,000 - 100,000	50,800	23,500
Antimony	84	15.5	1.038 - 2.531	0.647	0.378
Arsenic	307	99.3	1.224 - 97	6.9	7.64
Barium	342	100	100 - 3,000	642	330
Beryllium	342	36.0	1 - 7	0.991	0.876
Boron	342	66.7	20 - 150	27.9	19.7
Bromine	85	50.6	0.5038 - 3.522	0.681	0.599
Calcium	342	100	0.055 - 32	3.09	4.13
Carbon	85	100	0.3 - 10	2.18	1.92
Cerium	291	16.2	150 - 300	90	38.4
Chromium	342	100	3 - 500	48.2	41
Cobalt	342	88.6	3 - 30	8.09	5.03
Copper	342	100	2 - 200	23.1	17.7
Fluorine	264	97.3	10 - 1,900	394	261
Gallium	340	99.1	5 - 50	18.3	8.9
Germanium	85	100	0.578 - 2.146	1.18	0.316
Iodine	85	78.8	0.516 - 3.487	1.07	0.708
Iron	342	100	3,000 - 100,000	21,100	13,500
Lanthanum	341	66.3	30 - 200	39.8	28.8
Lead	342	92.7	10 - 700	24.8	41.5
Lithium	307	100	5 - 130	25.3	14.4
Magnesium	341	100	300 - 50,000	8,630	6,400
Manganese	342	100	70 - 2,000	414	272
Mercury	309	99.0	0.01 - 4.6	0.0768	0.276
Molybdenum	340	3.53	3 - 7	1.59	0.522
Neodymium	256	22.7	70 - 300	47.1	31.7
Nickel	342	96.5	5 - 700	18.8	39.8
Niobium	335	63.3	10 - 100	11.4	8.68
Phosphorus	249	100	40 - 4,497	399	397
Potassium	341	100	1,900 - 63,000	18,900	6,980
Rubidium	85	100	35 - 140	75.8	25
Scandium	342	85.1	5 - 30	8.64	4.69
Selenium	309	80.6	0.1023 - 4.3183	0.349	0.415
Silicon	85	100	149,340 - 413,260	302,000	61,500
Sodium	335	100	500 - 70,000	10,400	6,260
Strontium	342	100	10 - 2,000	243	212
Sulfur	85	16.5	816 - 47,760	1,250	5,300
Thallium	76	100	2.45 - 20.79	9.71	3.54
Tin	85	96.5	0.117 - 5.001	1.15	0.772
Titanium	342	100	500 - 7,000	2,290	1,350
Uranium	85	100	1.11 - 5.98	2.87	0.883
Vanadium	342	100	7 - 300	73	41.7
Ytterbium	330	99.1	1 - 20	3.33	2.06
Yttrium	342	98.0	10 - 150	26.9	18.1
Zinc	330	100	10 - 2,080	72.4	159
Zirconium	342	100	30 - 1,500	220	157

[a] Based on data from Shacklette and Boerngen 1984 for the states of Colorado, Arizona, Kansas, Nebraska, New Mexico, Oklahoma, Utah, and Wyoming.

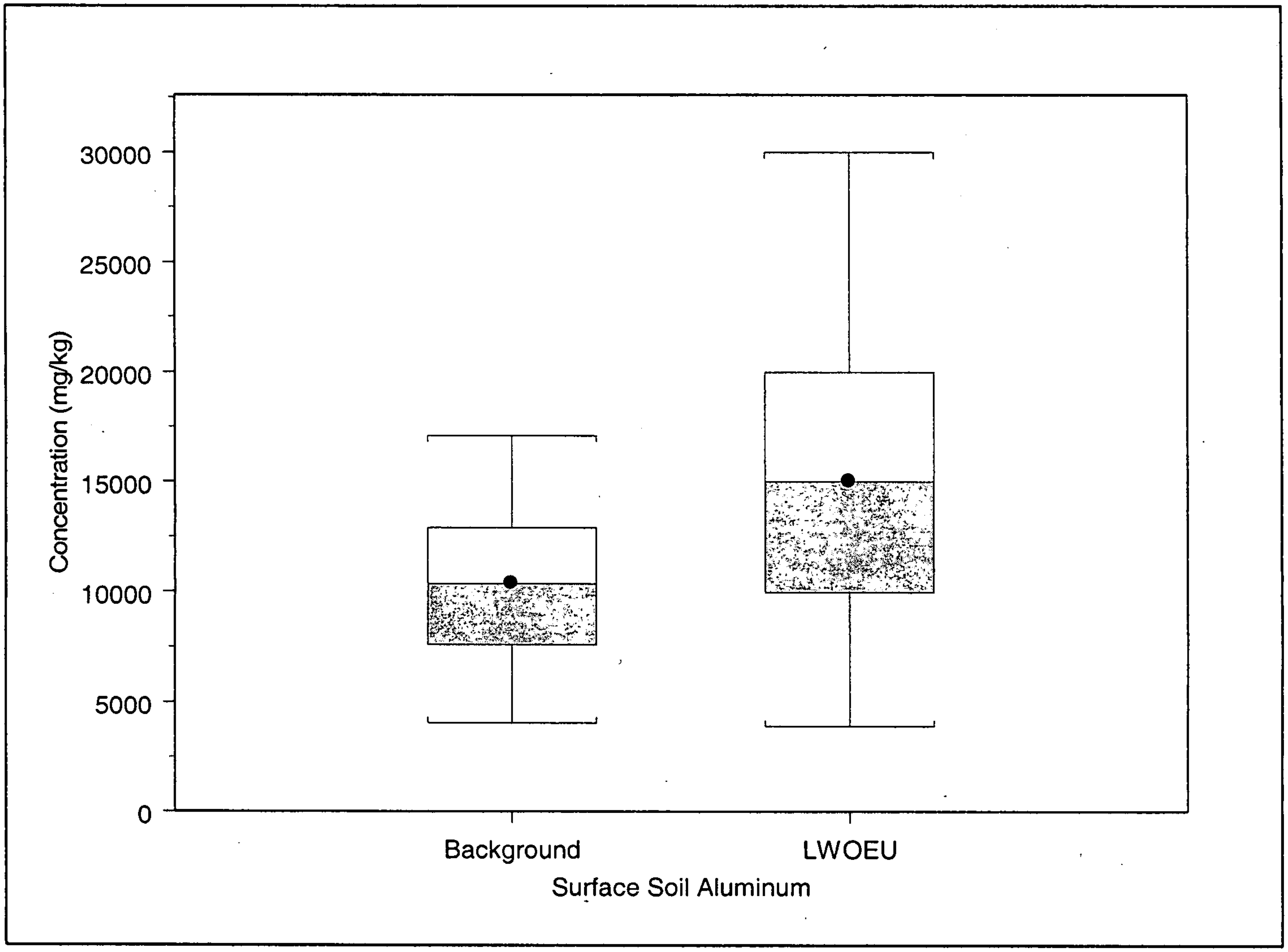
[b] One-half the detection limit used as proxy value for nondetects in computation of the mean and standard deviation.

FIGURES

202

203

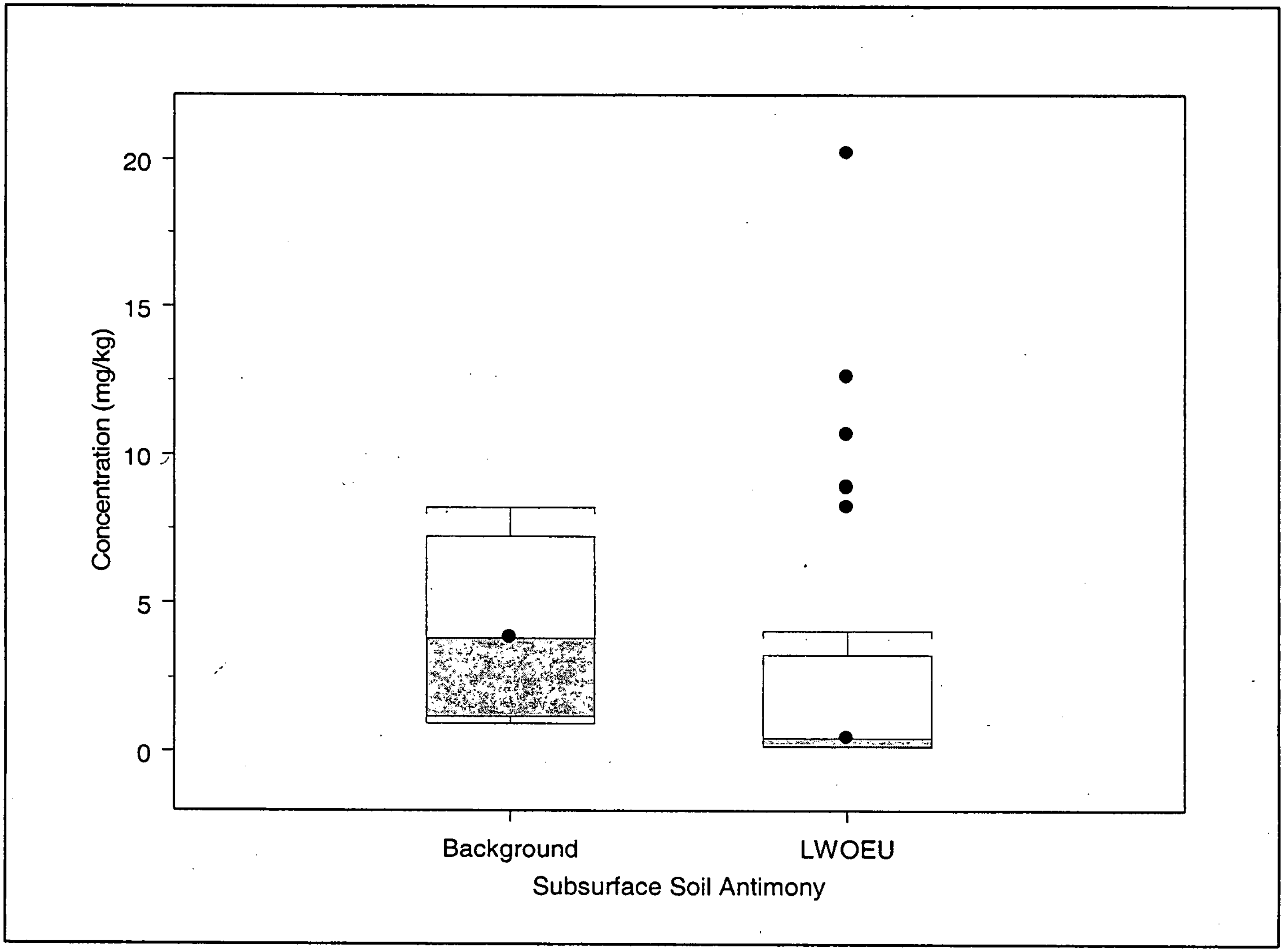
Figure A[illegible].2.1
LWOEU Surface Soil Box Plots for Aluminum



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

204

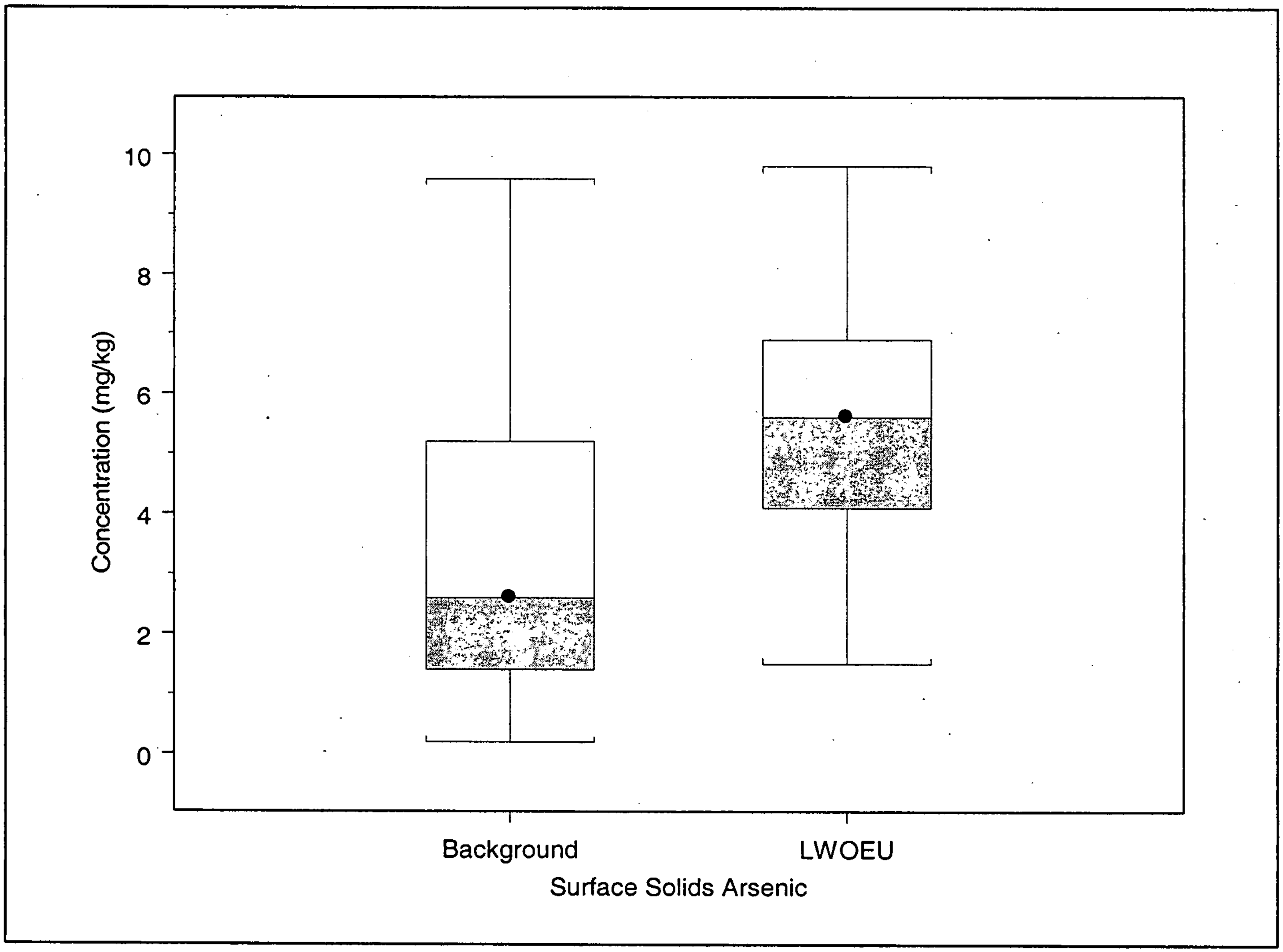
Figure A6.2.2
LWOEU Subsurface Soil Box Plots for Antimony



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

205

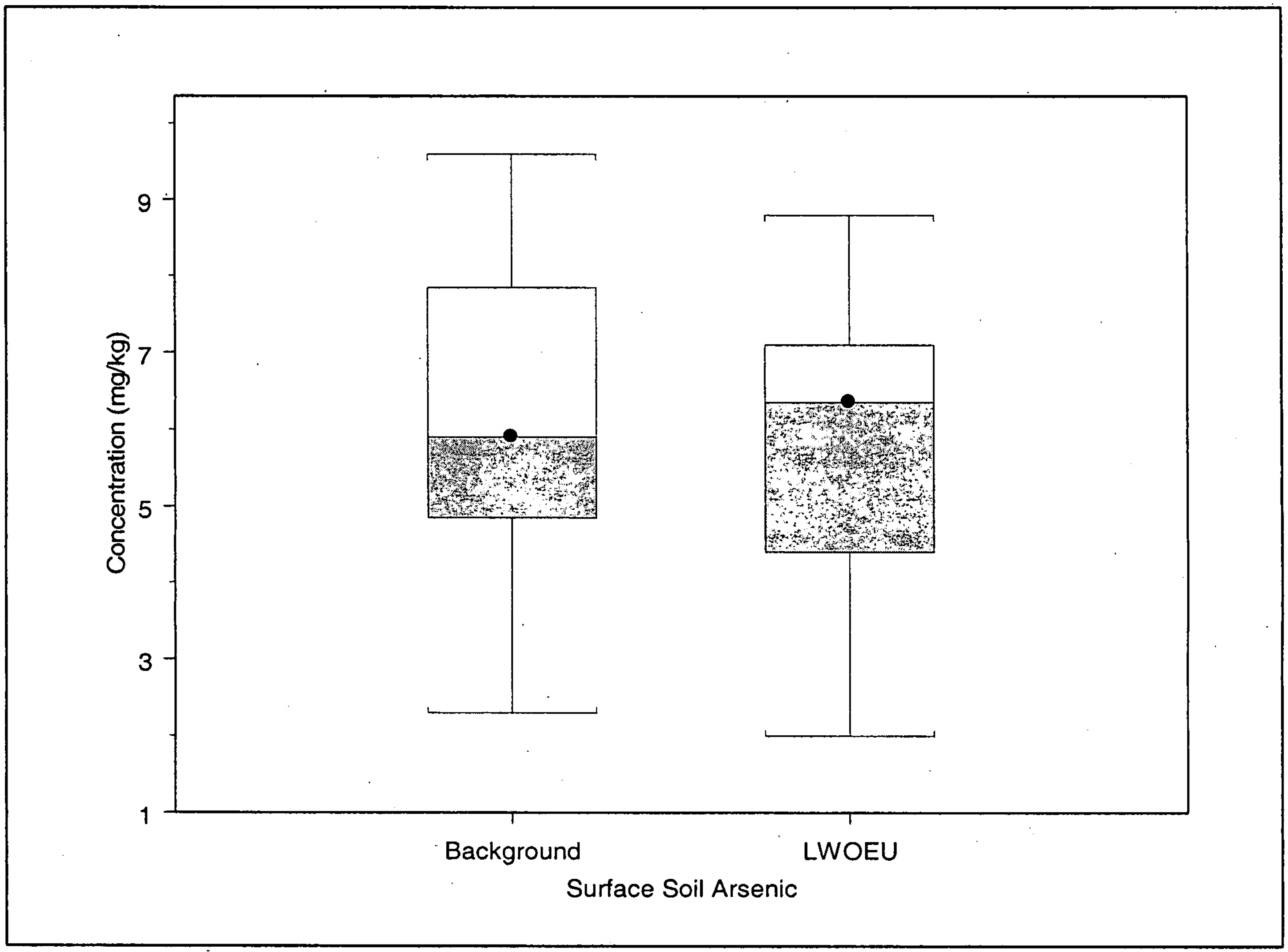
Figure A.2.3
LWOEU Surface Soil/Surface Sediment Box Plots for Arsenic



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

206

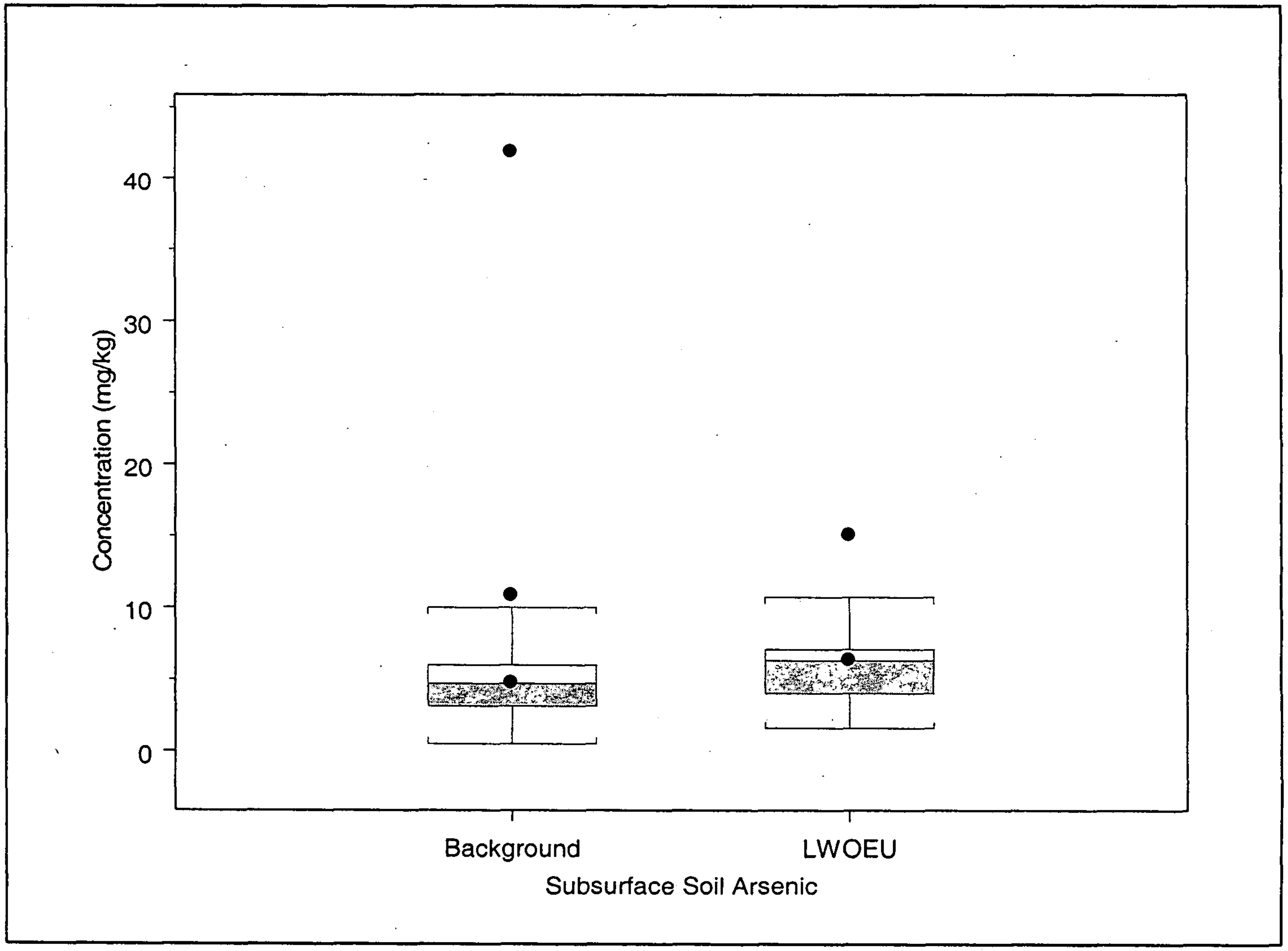
Figure [illegible].2.4
LWOEU Surface Soil Box Plots for Arsenic



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

207

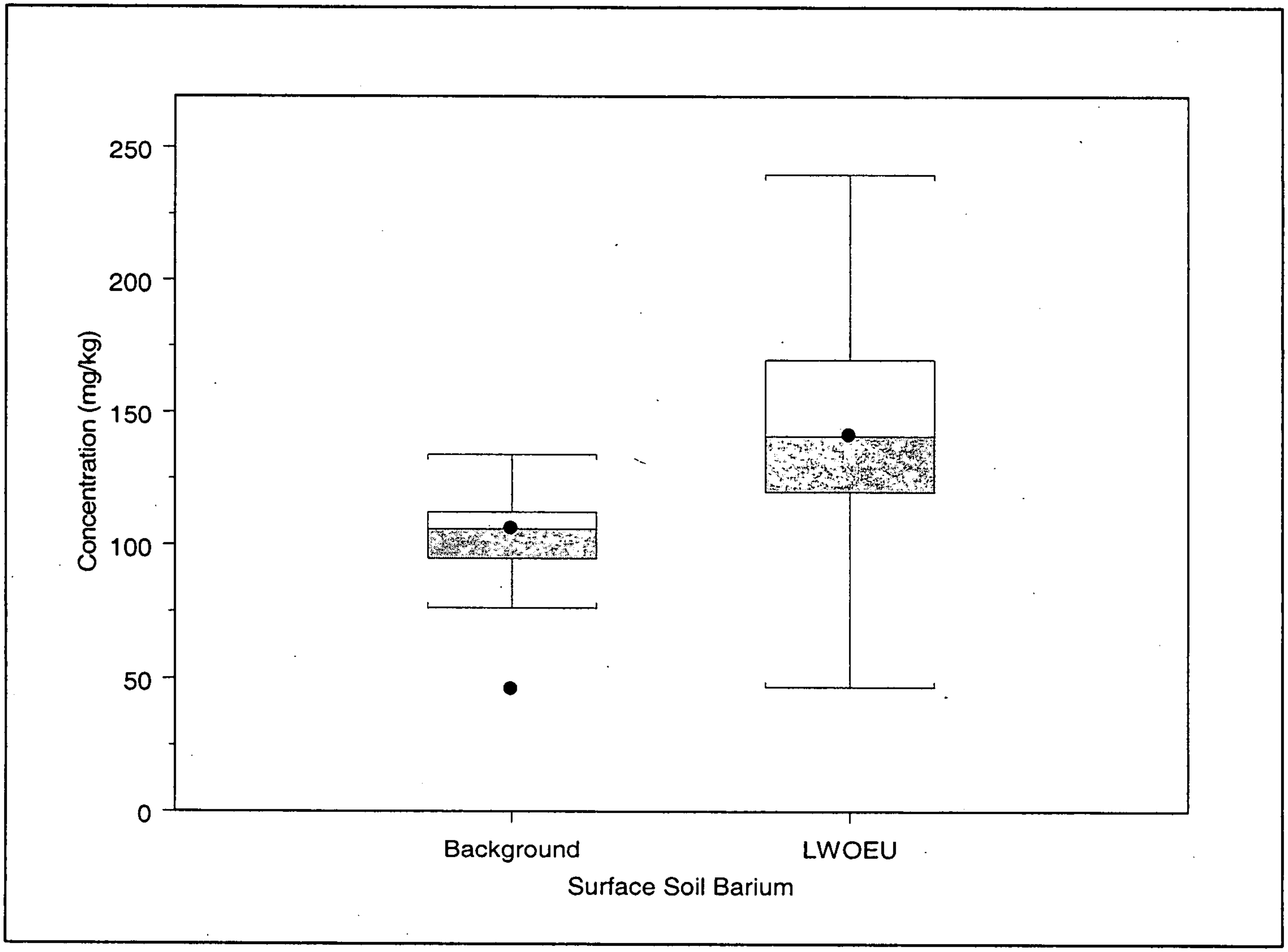
Figure [illegible].2.5
LWOEU Subsurface Soil Box Plots for Arsenic



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

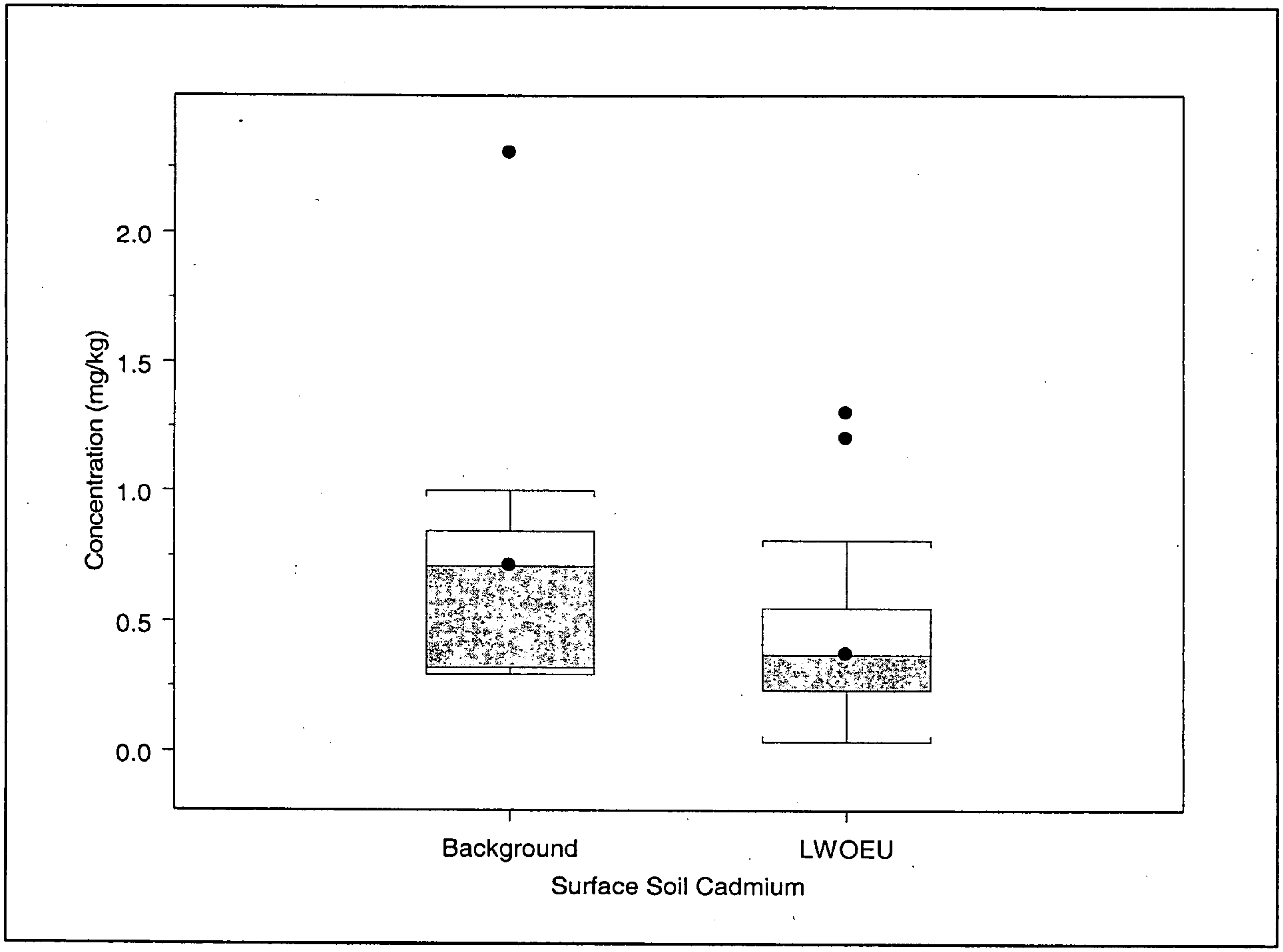
208

Figure A3.2.6
LWOEU Surface Soil Box Plots for Barium



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

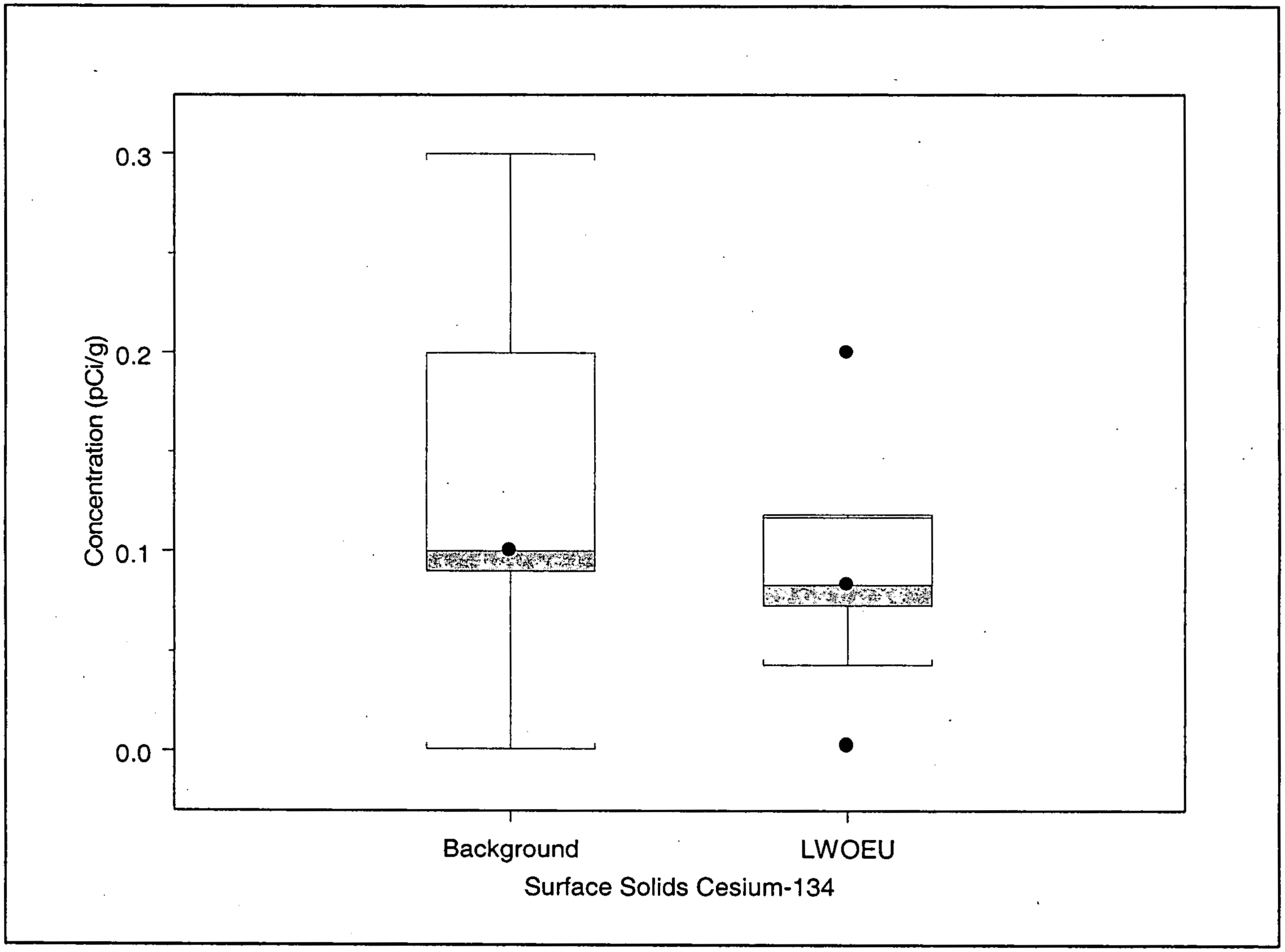
Figure A3.2.7
LWOEU Surface Soil Box Plots for Cadmium



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

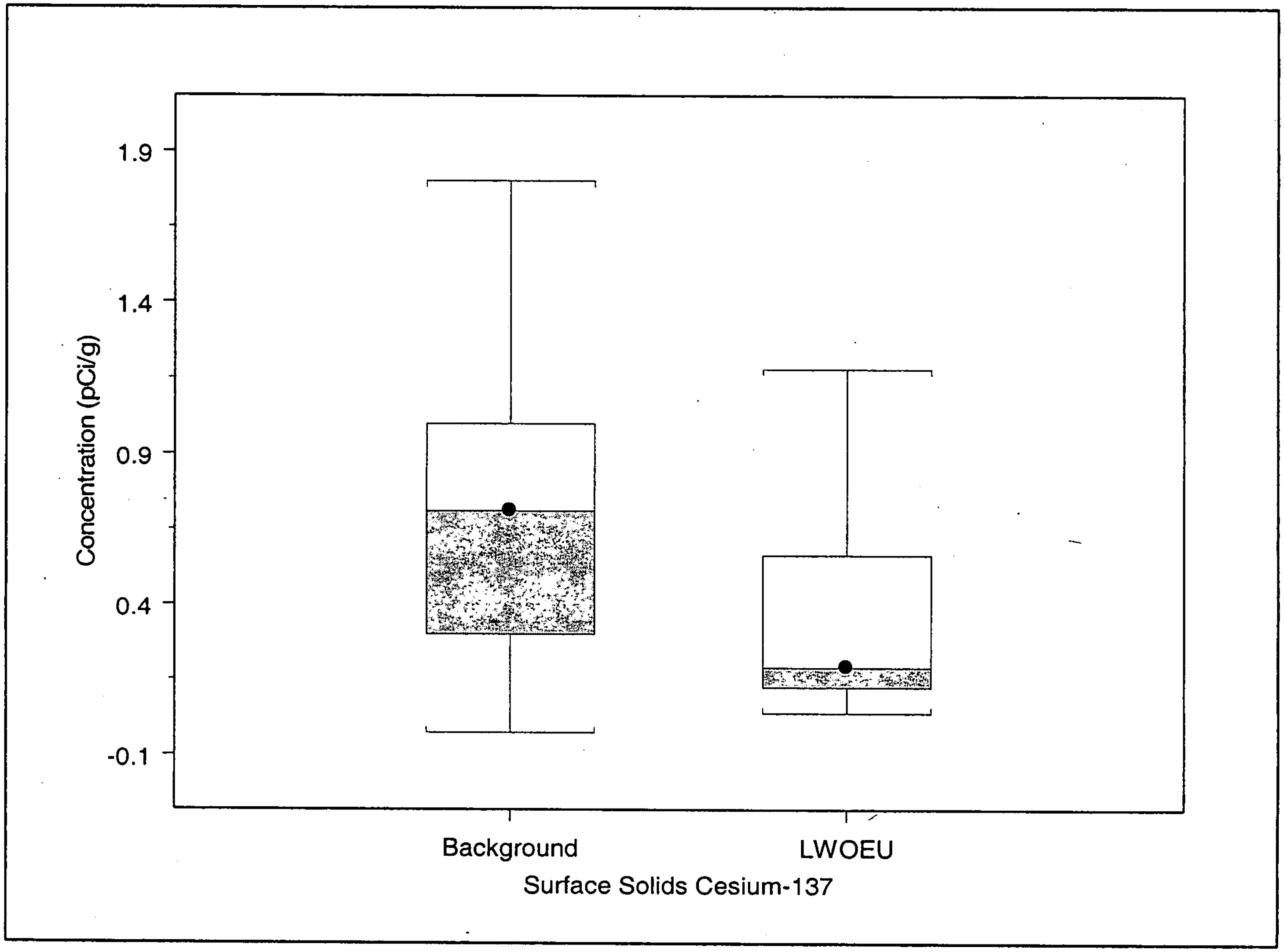
210

Figure A3.2.8
LWOEU Surface Soil/Surface Sediment Box Plots for Cesium-134



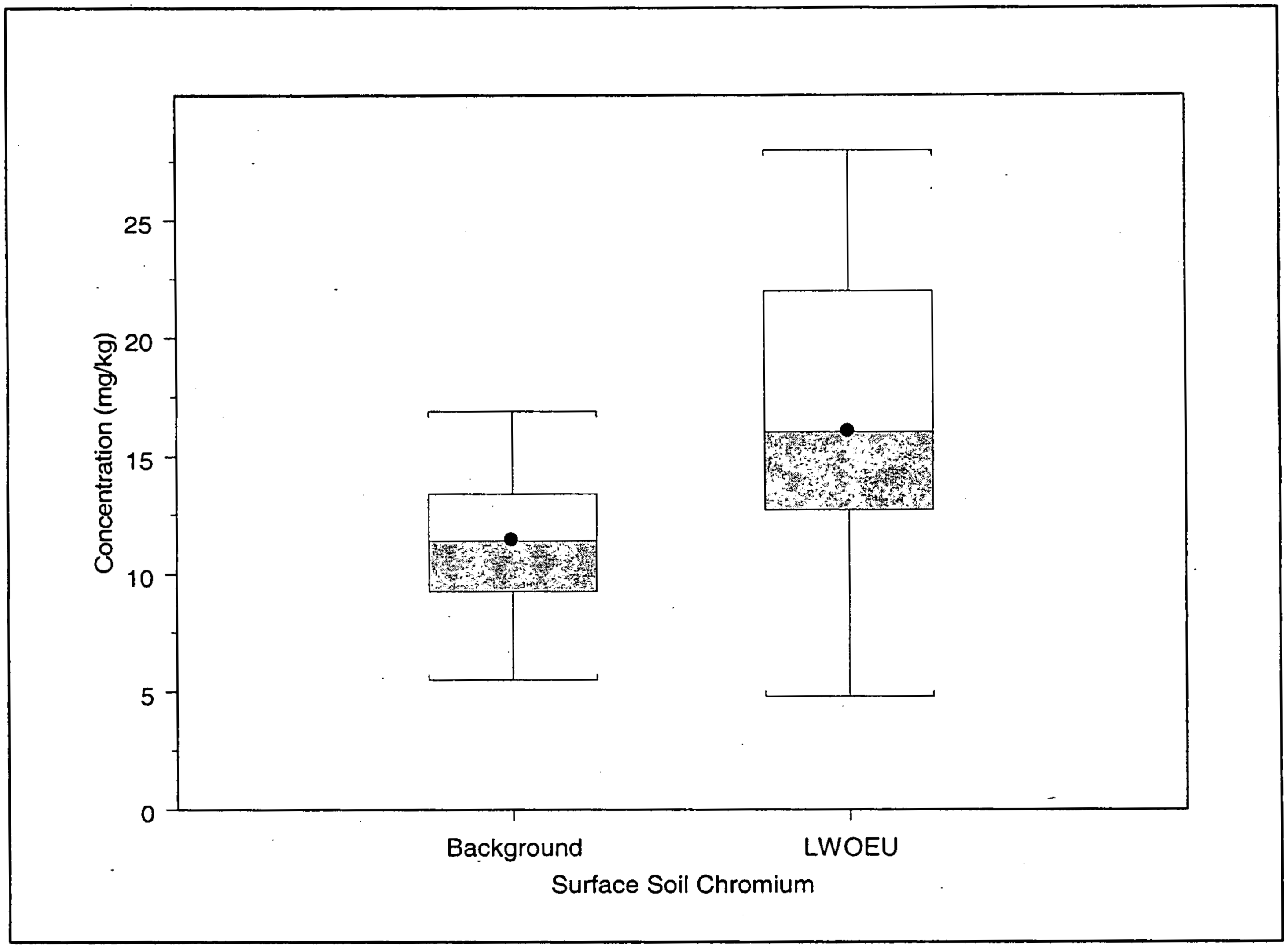
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

Figure A3.2.9
LWOEU Surface Soil/Surface Sediment Box Plots for Cesium-137



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

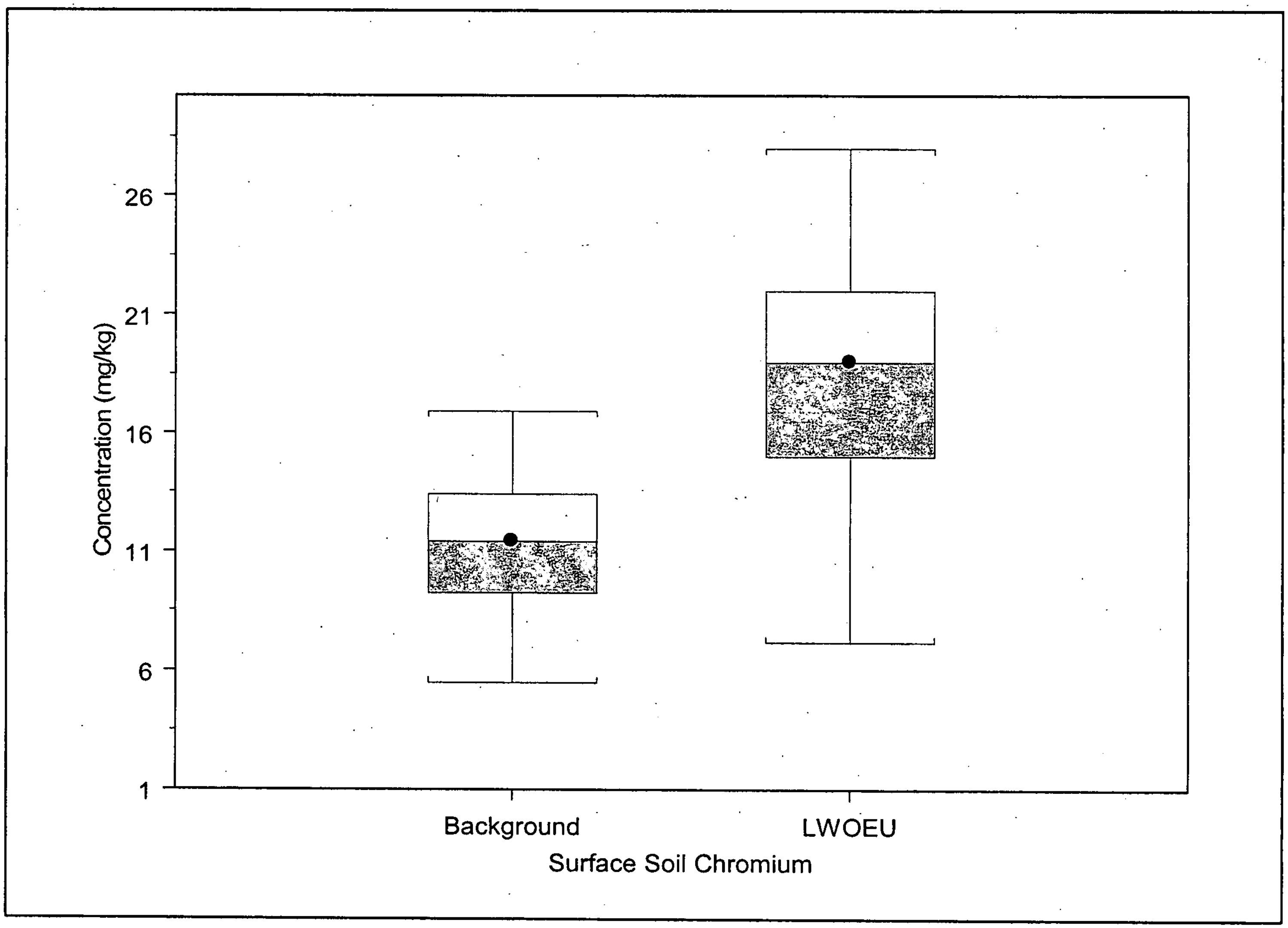
Figure [illegible].2.10
LWOEU Surface Soil Box Plots for Chromium



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

2/3

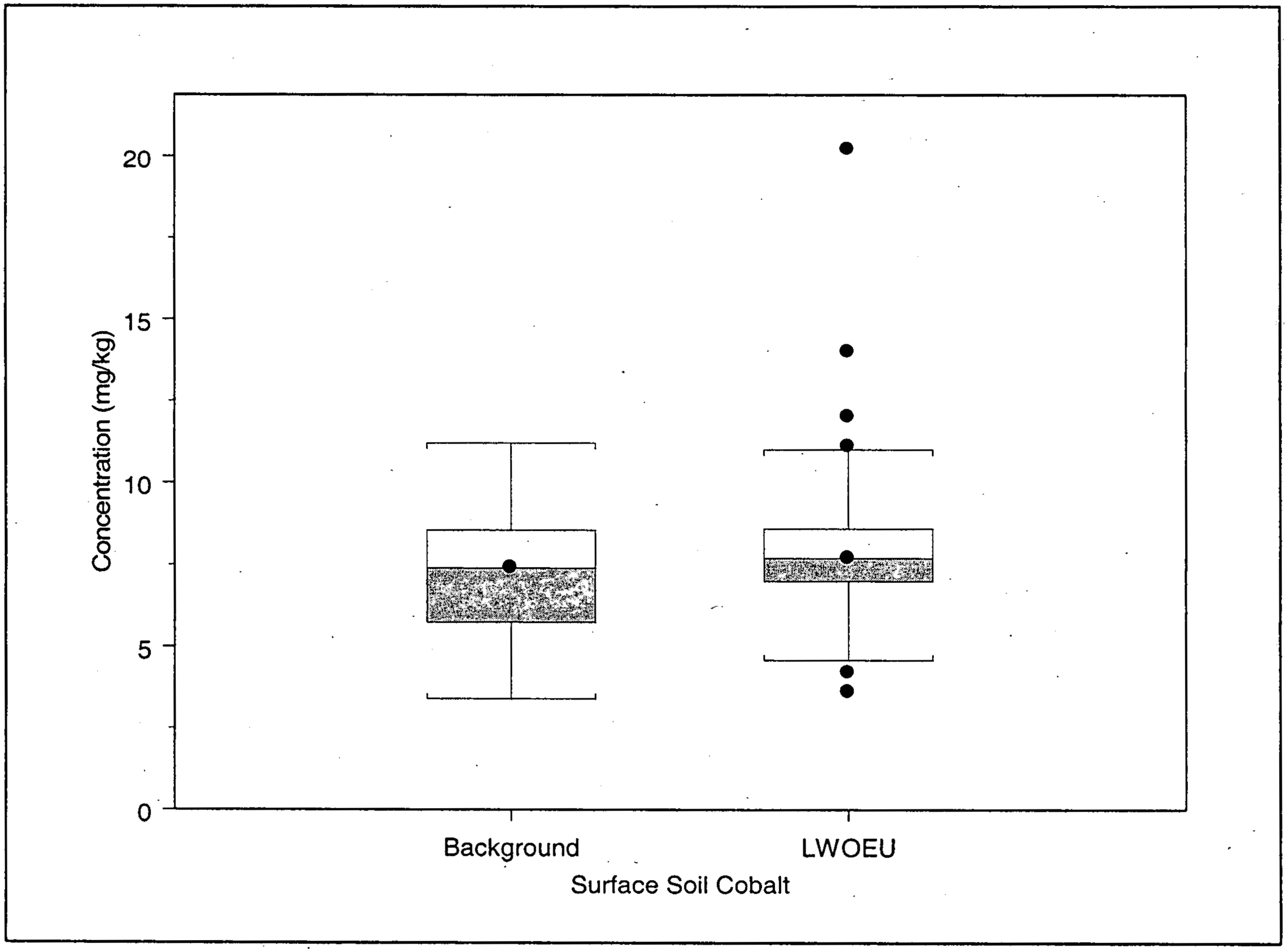
Figure A[illegible].11
LWOEU Surface Soil (PMJM) Box Plots for Chromium



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

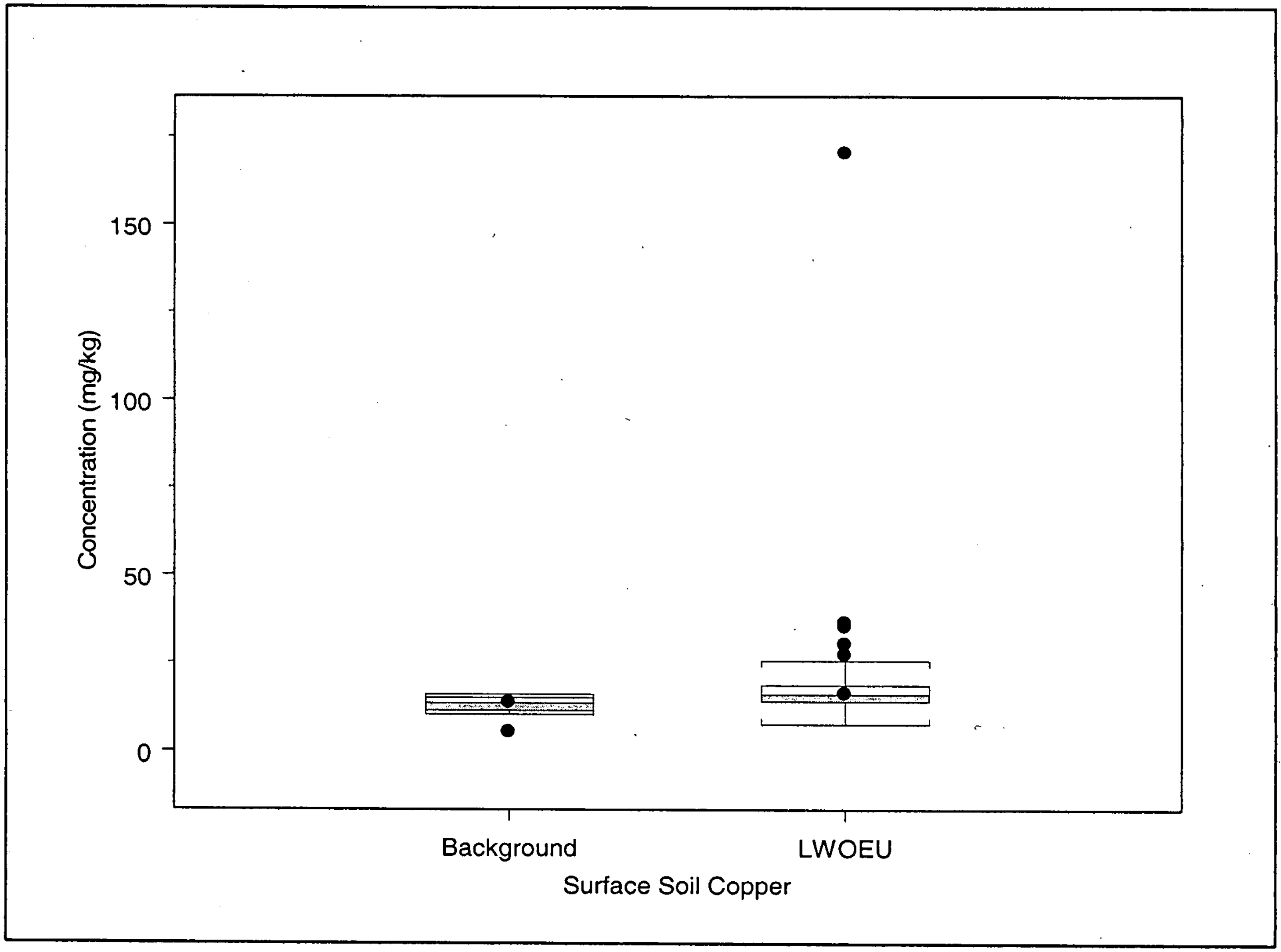
214

Figure [illegible].2.12
LWOEU Surface Soil Box Plots for Cobalt



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

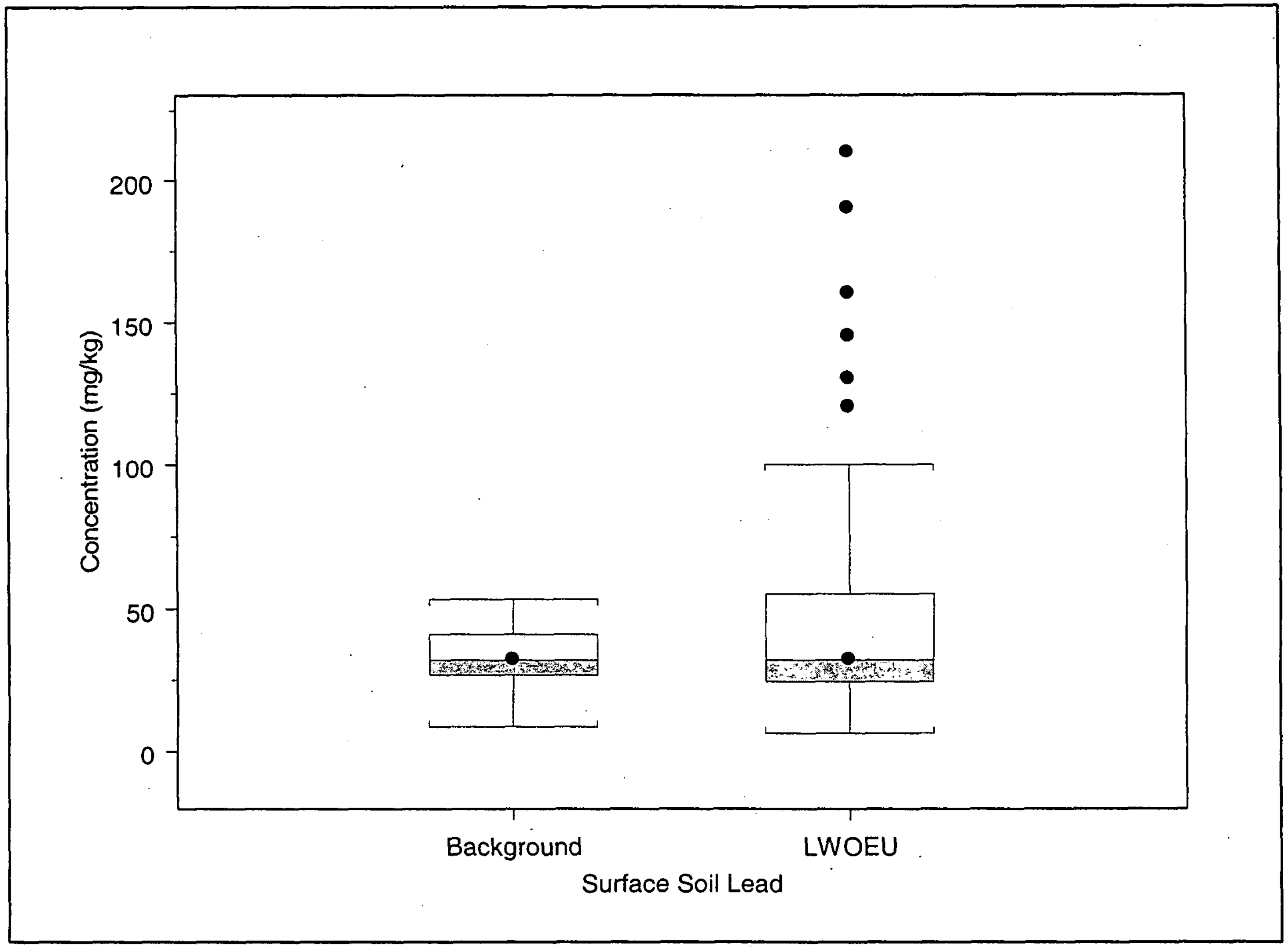
Figure [illegible].2.13
LWOEU Surface Soil Box Plots for Copper



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

216

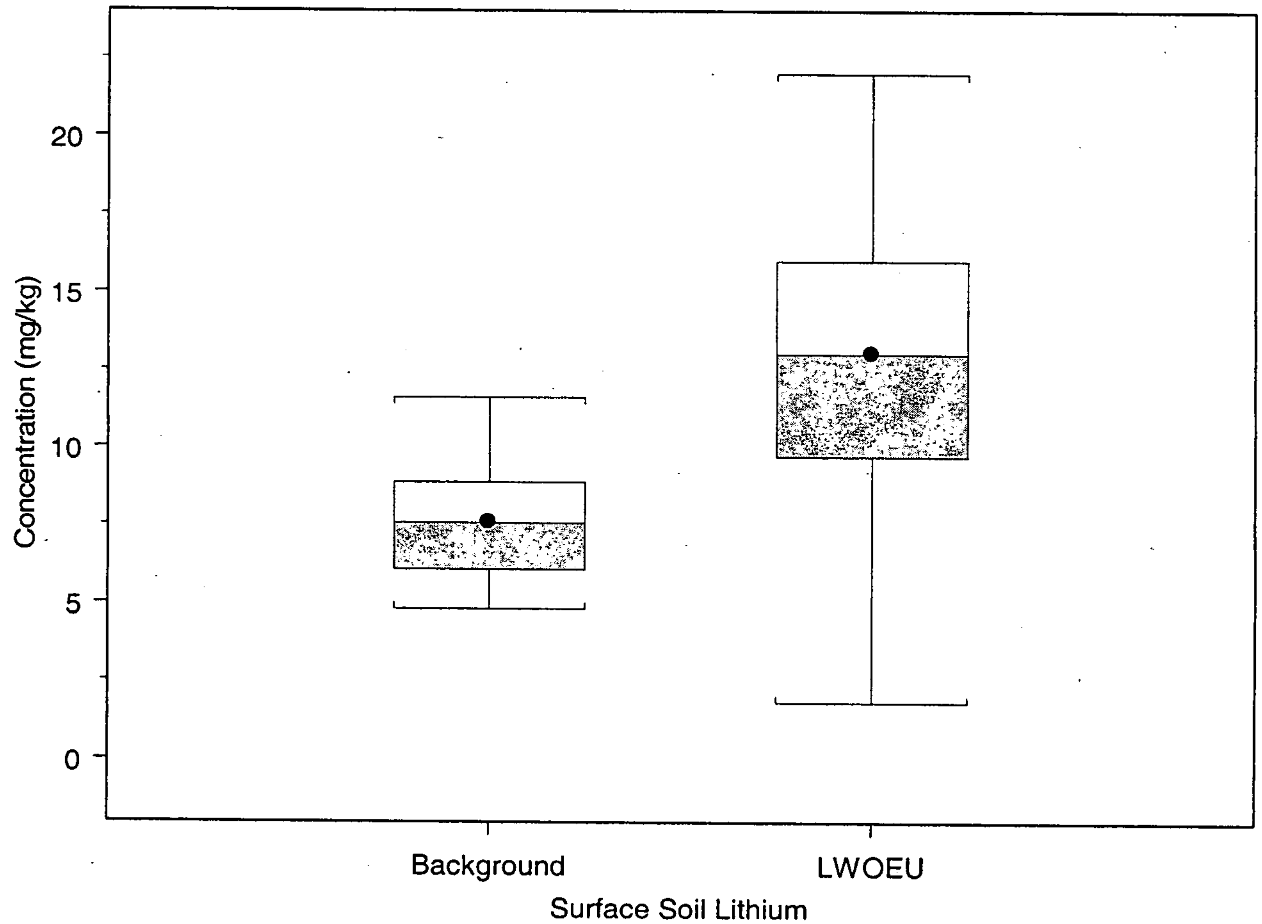
Figure A3.2.14
LWOEU Surface Soil Box Plots for Lead



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

217

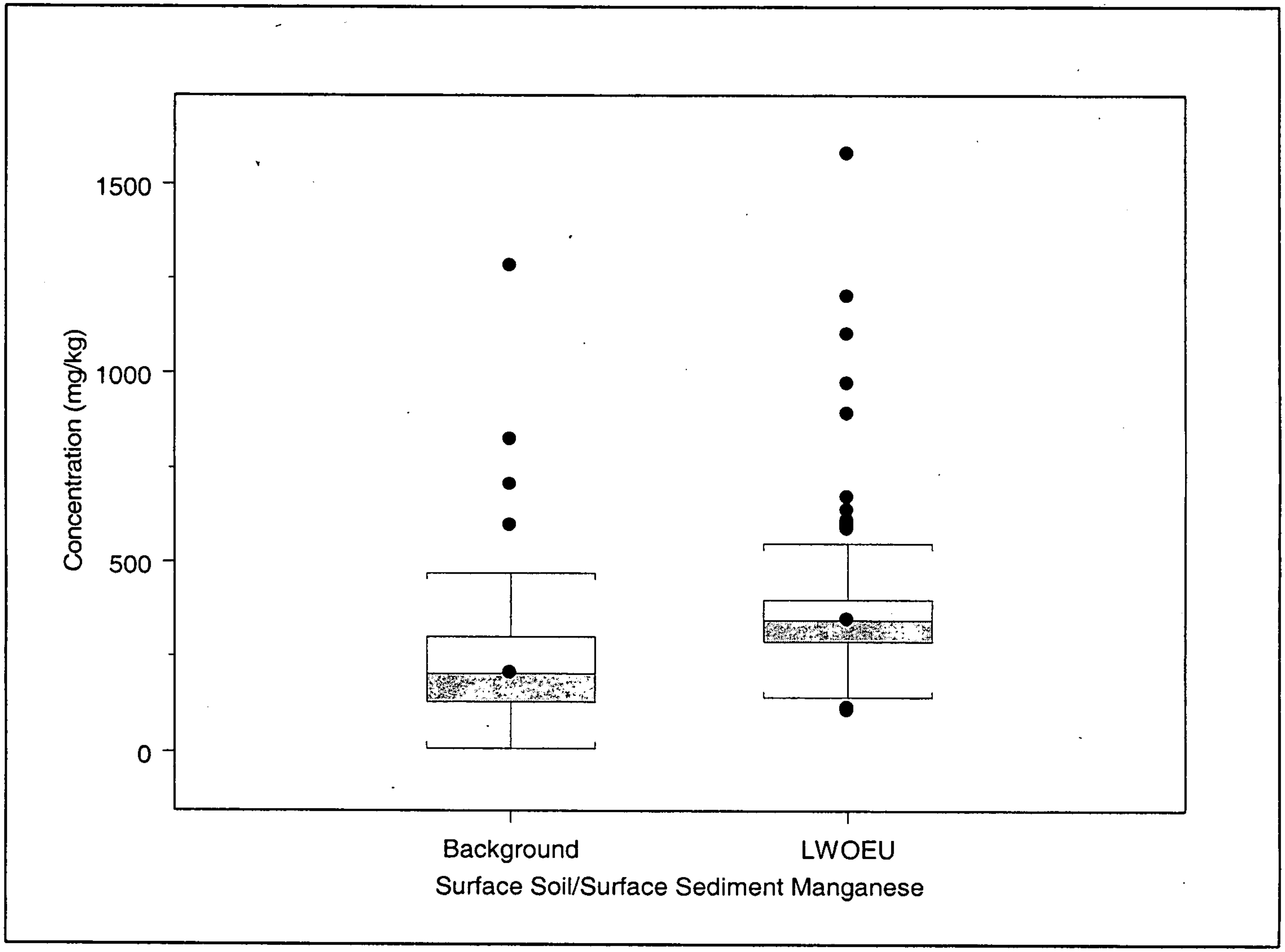
Figure A6.2.15
LWOEU Surface Soil Box Plots for Lithium



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

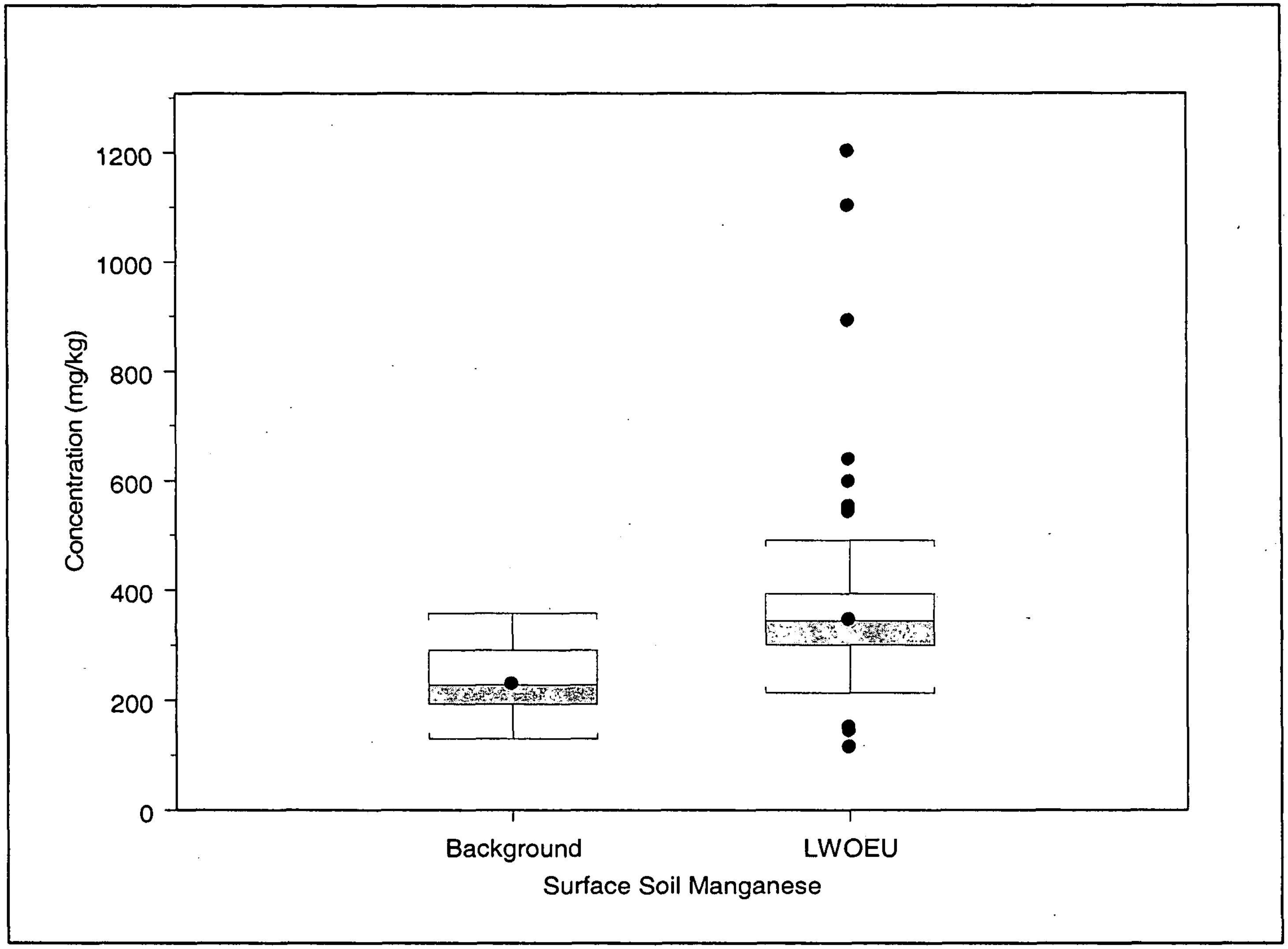
2/8

Figure [illegible].2.16
LWOEU Surface Soil/Surface Sediment Box Plots for Manganese



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

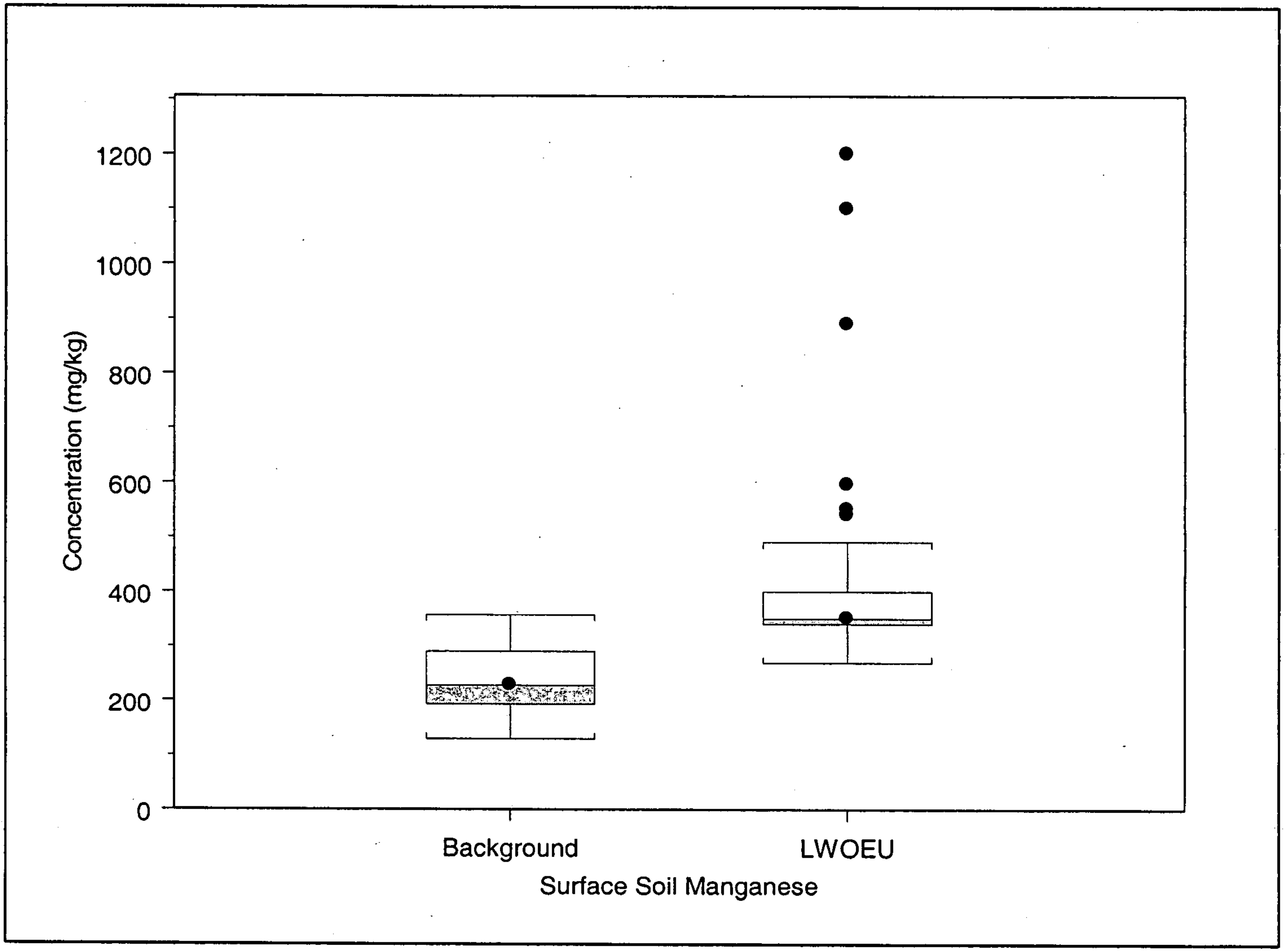
Figure [illegible].2.17
LWOEU Surface Soil Box Plots for Manganese



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

220

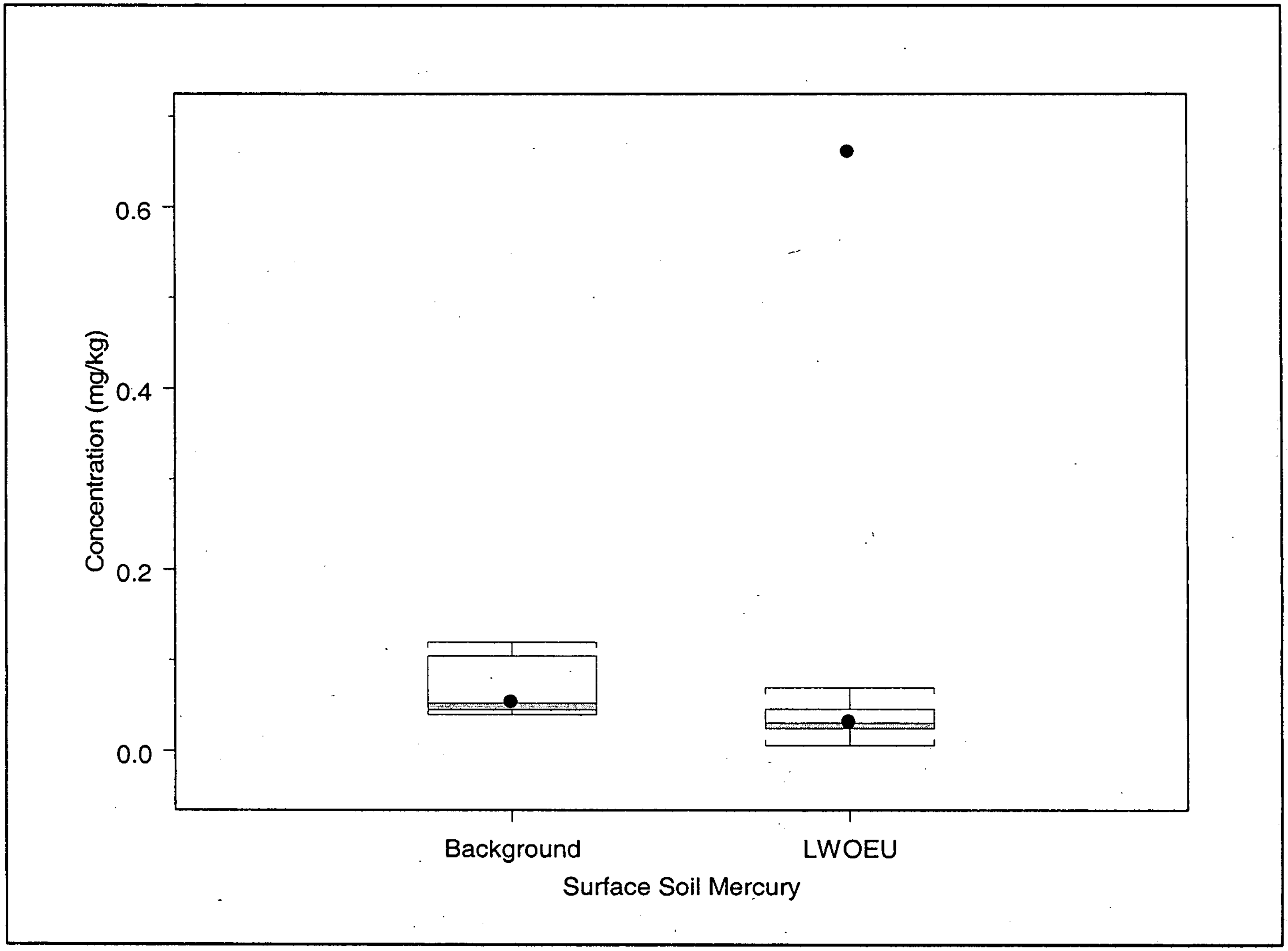
Figure [illegible].2.18
LWOEU Surface Soil (PMJM) Box Plots for Manganese



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

221

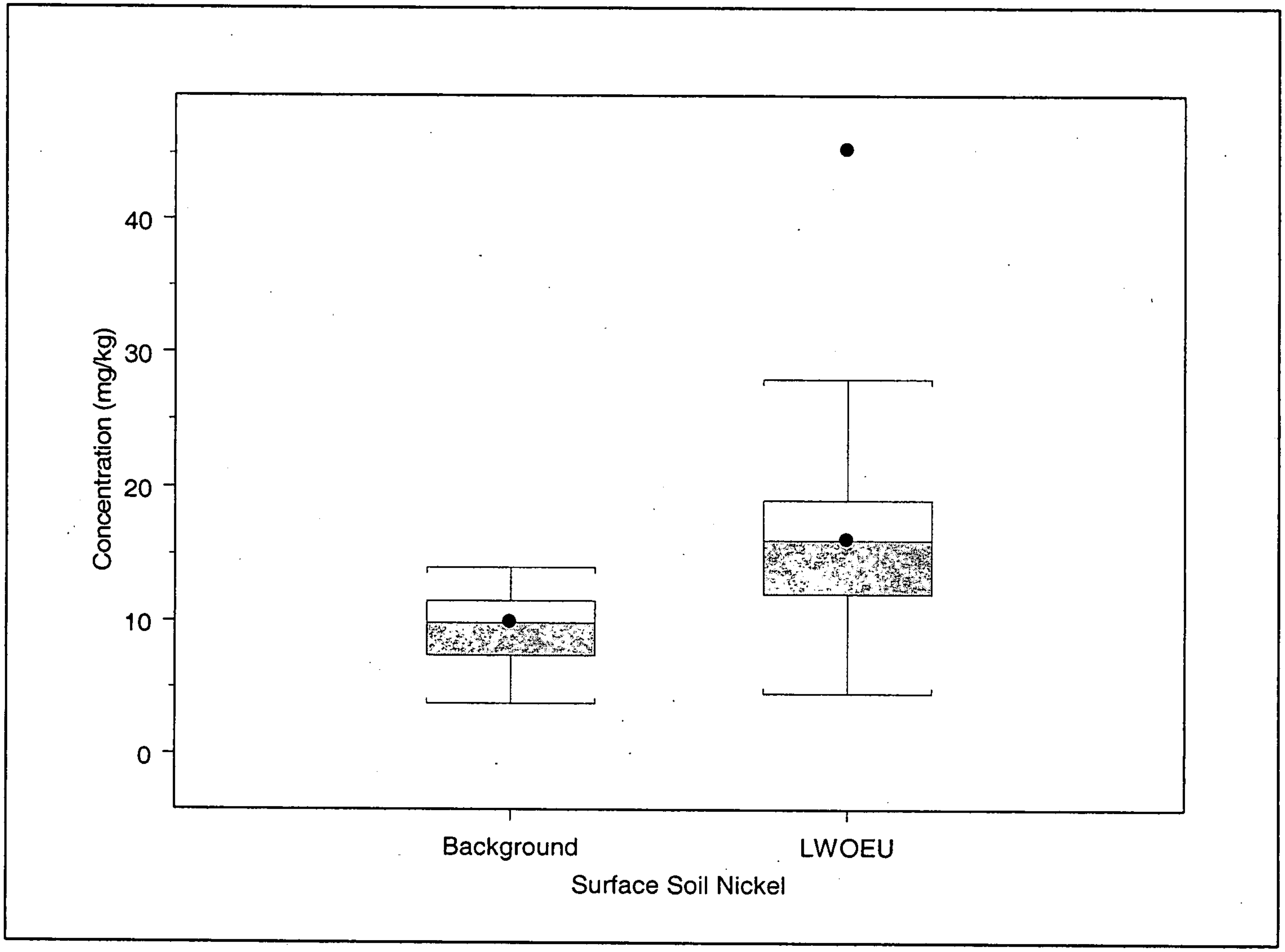
Figure A6.2.19
LWOEU Surface Soil Box Plots for Mercury



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

274

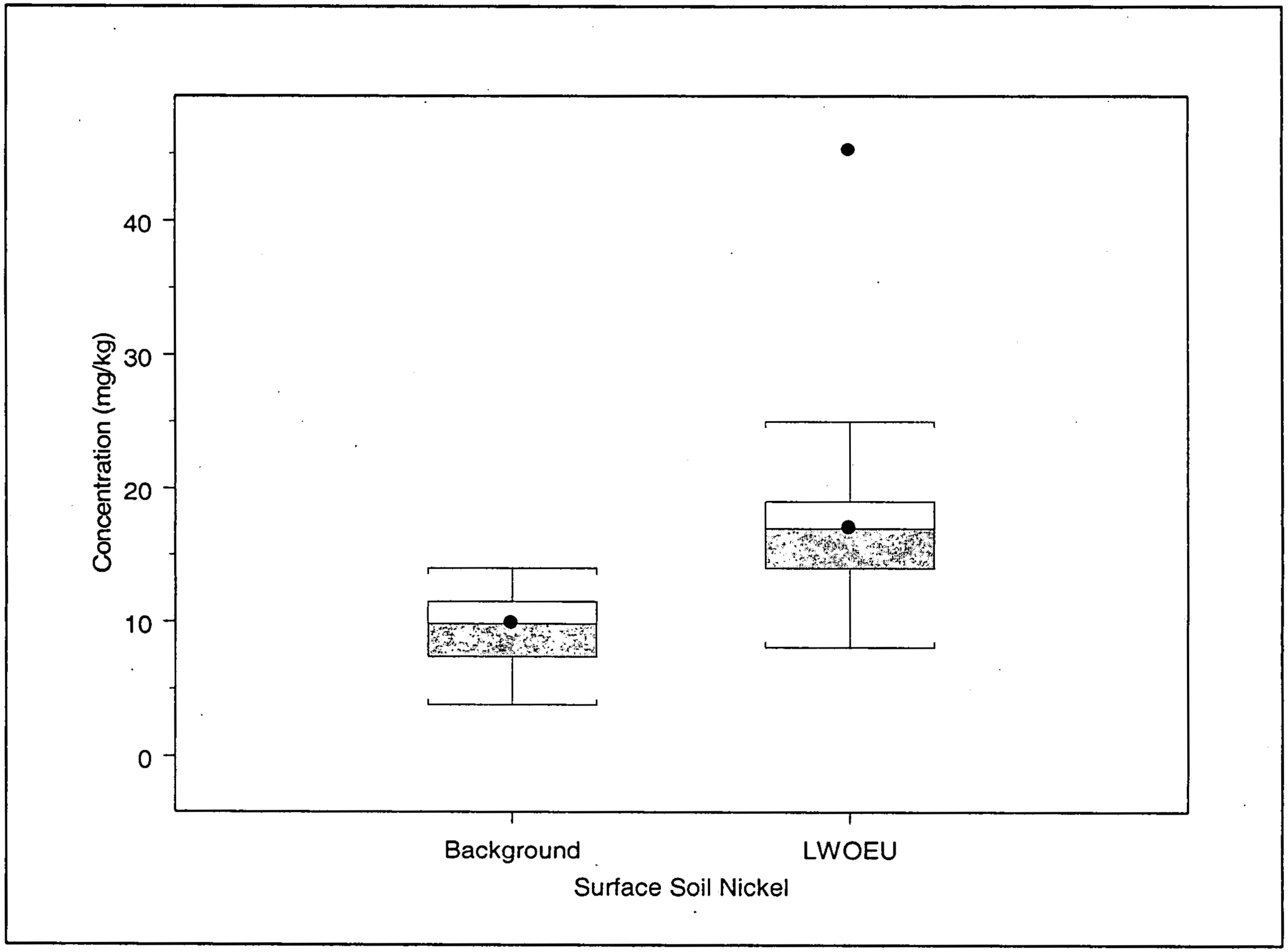
Figur[illegible].2.20
LWOEU Surface Soil Box Plots for Nickel



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

223

Figure A3.2.21
LWOEU Surface Soil (PMJM) Box Plots for Nickel

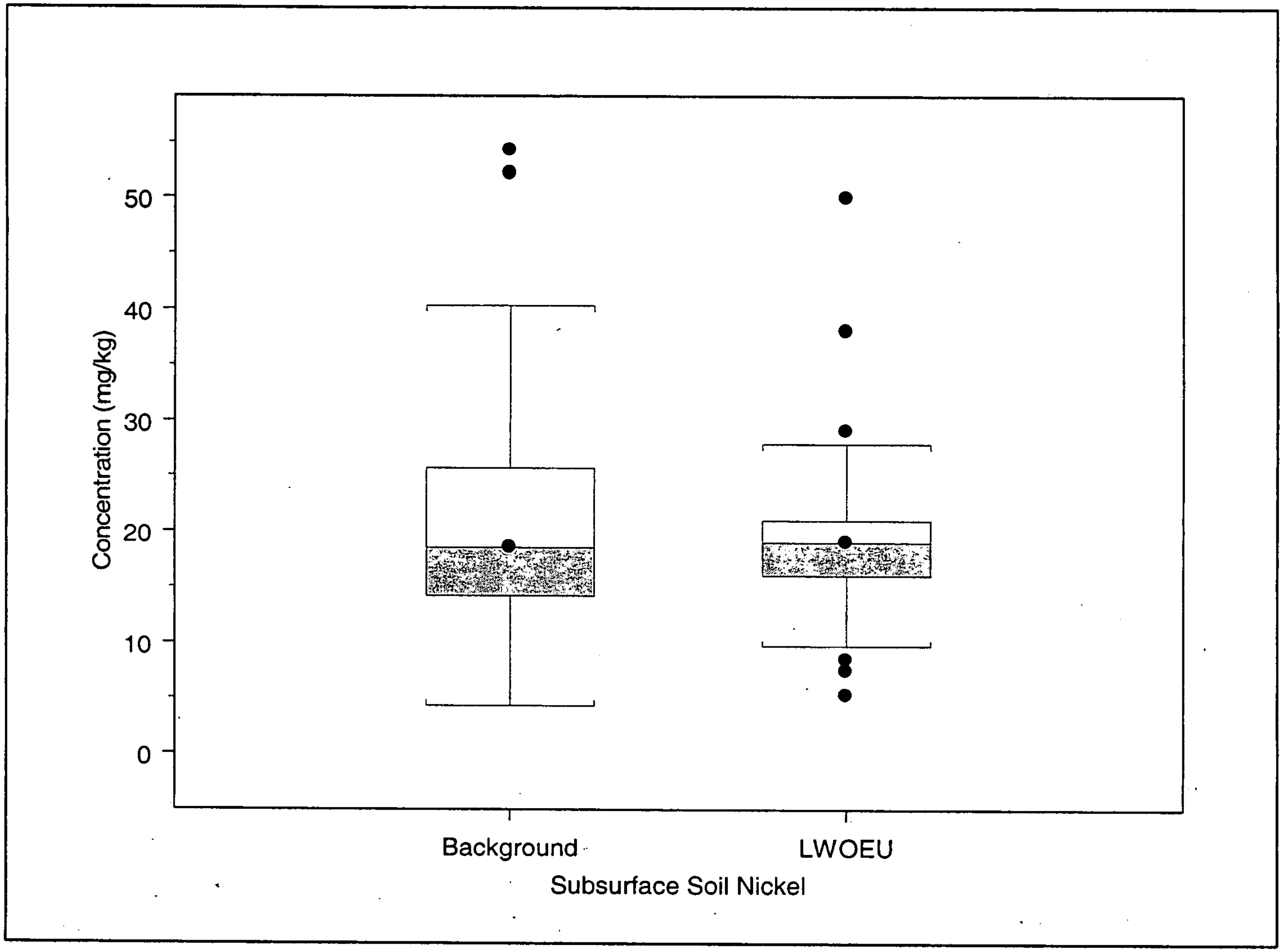


Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

224

Figure [illegible].2.22

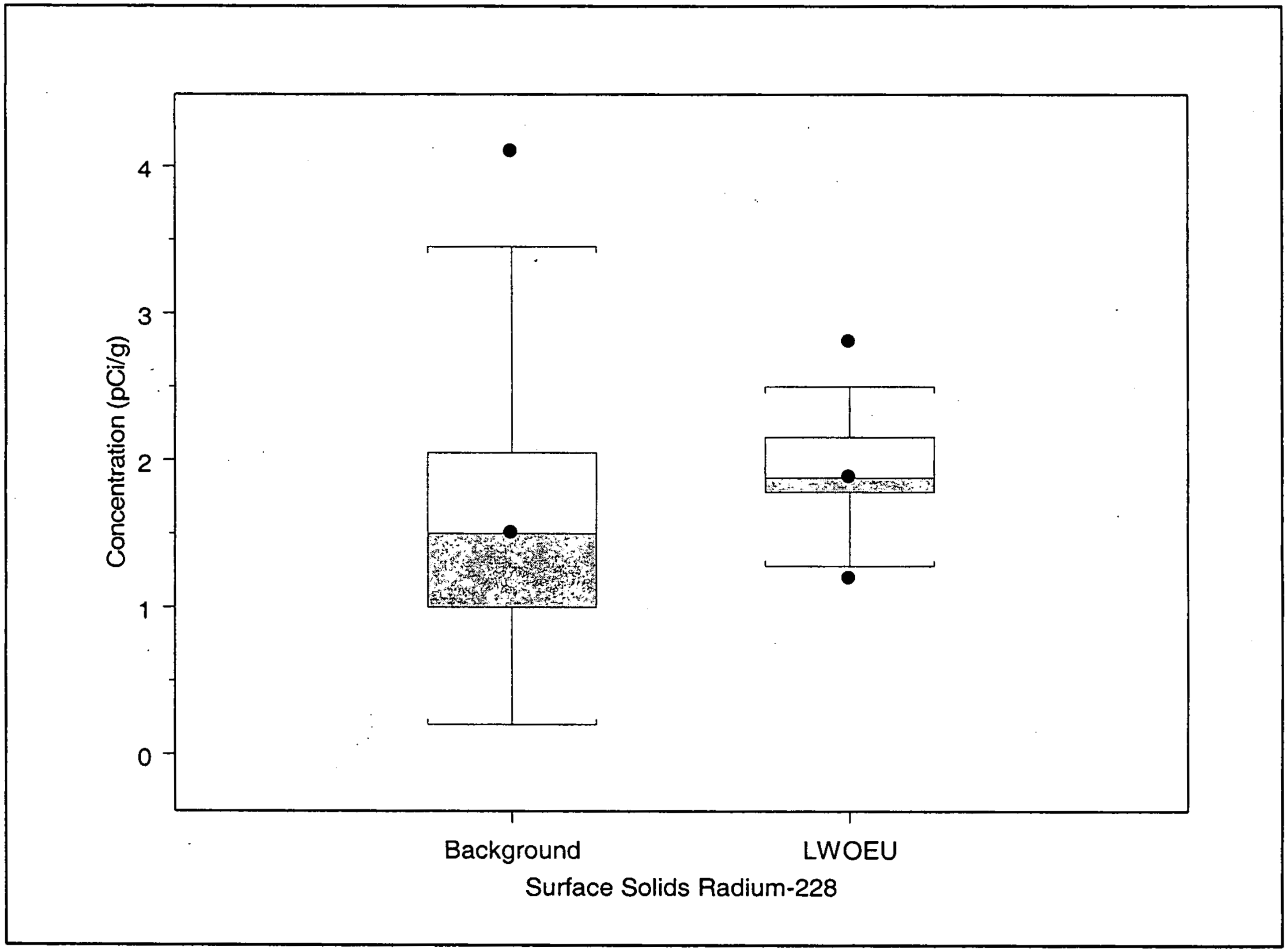
LWOEU Subsurface Soil Box Plots for Nickel



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

225

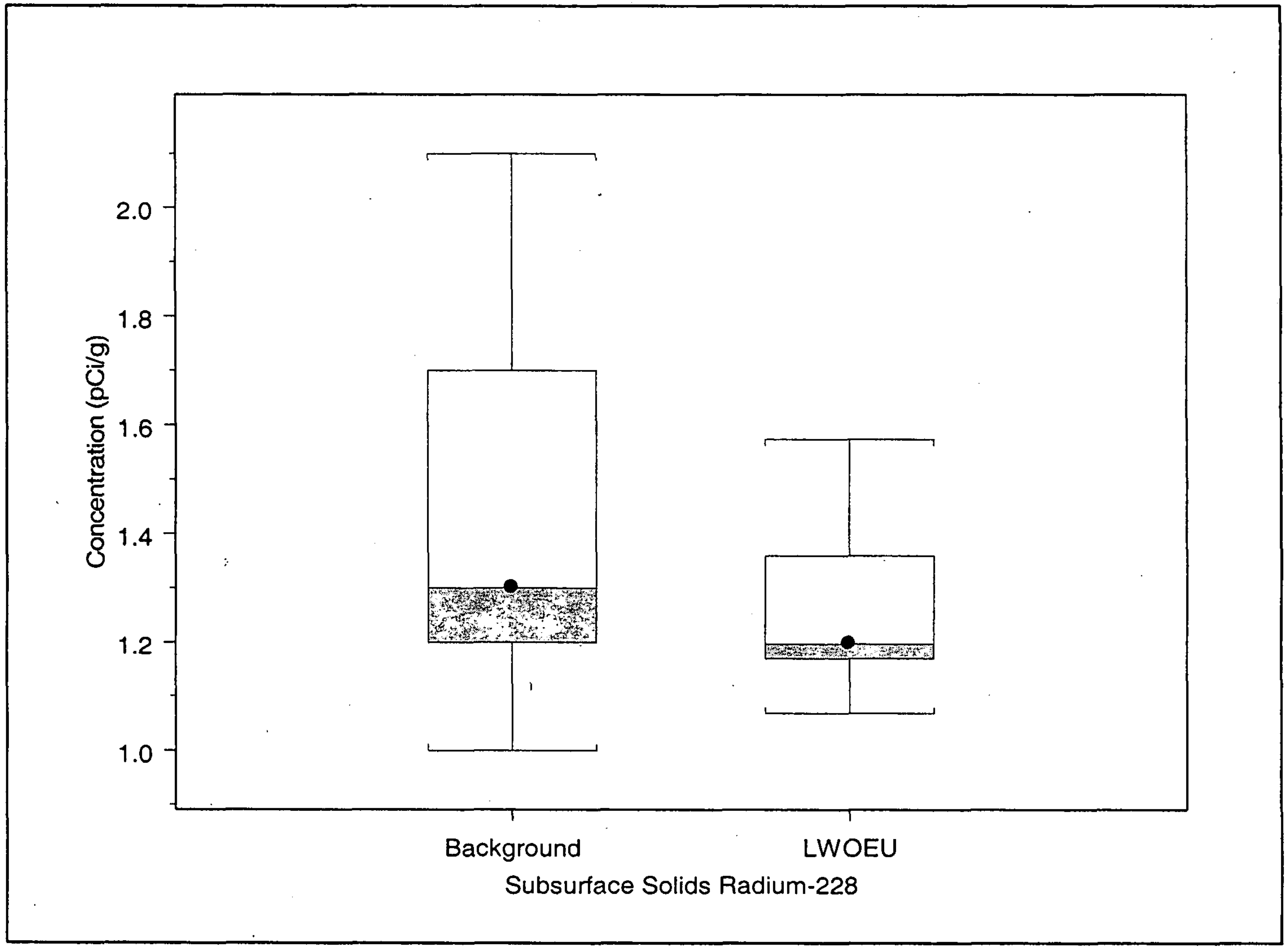
Figure [illegible].2.23
LWOEU Surface Soil/Surface Sediment Box Plots for Radium-228



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

226

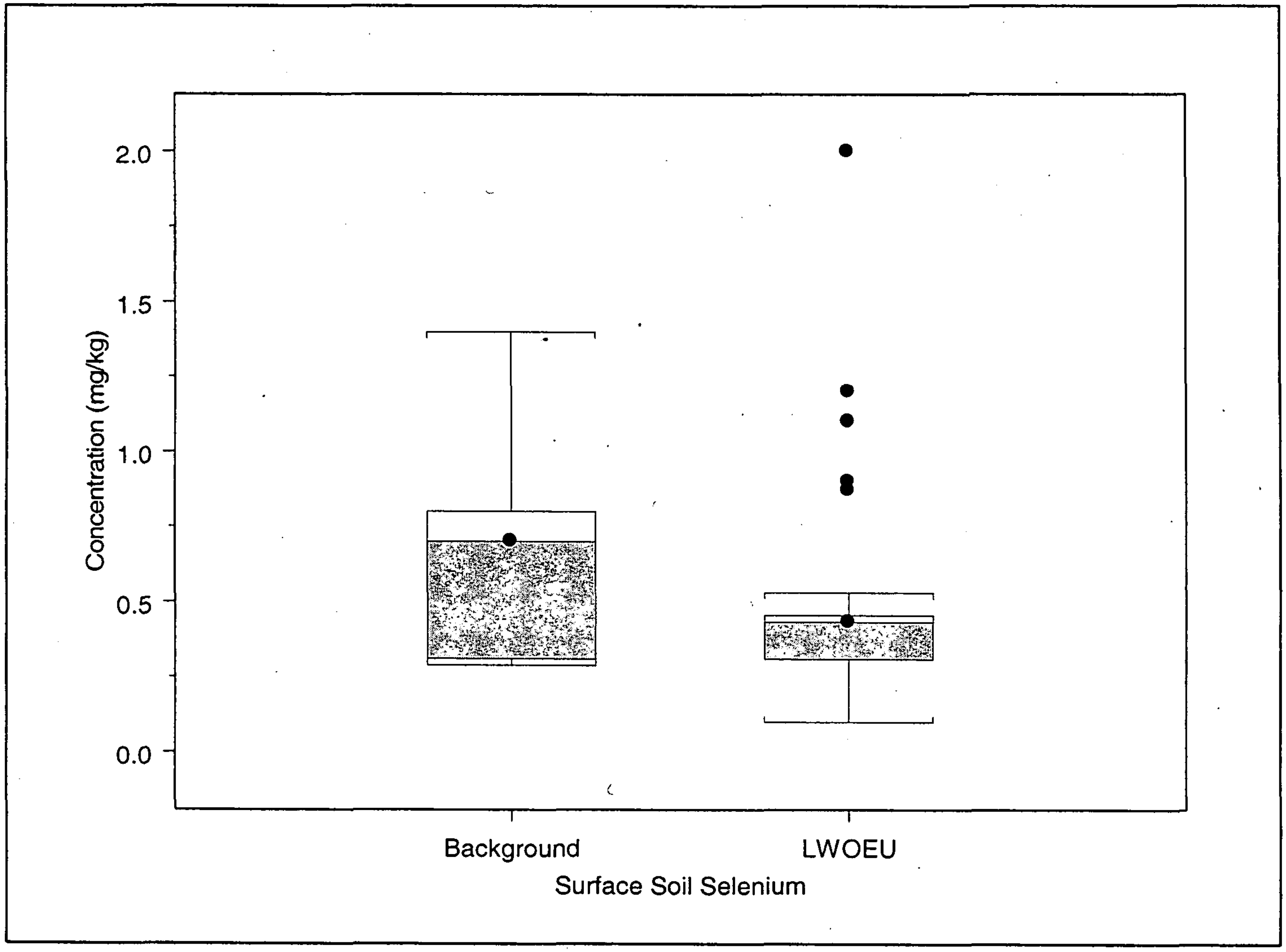
Figure [illegible].2.24
LWOEU Subsurface Soil/Subsurface Sediment Box Plots for Radium-228



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

227

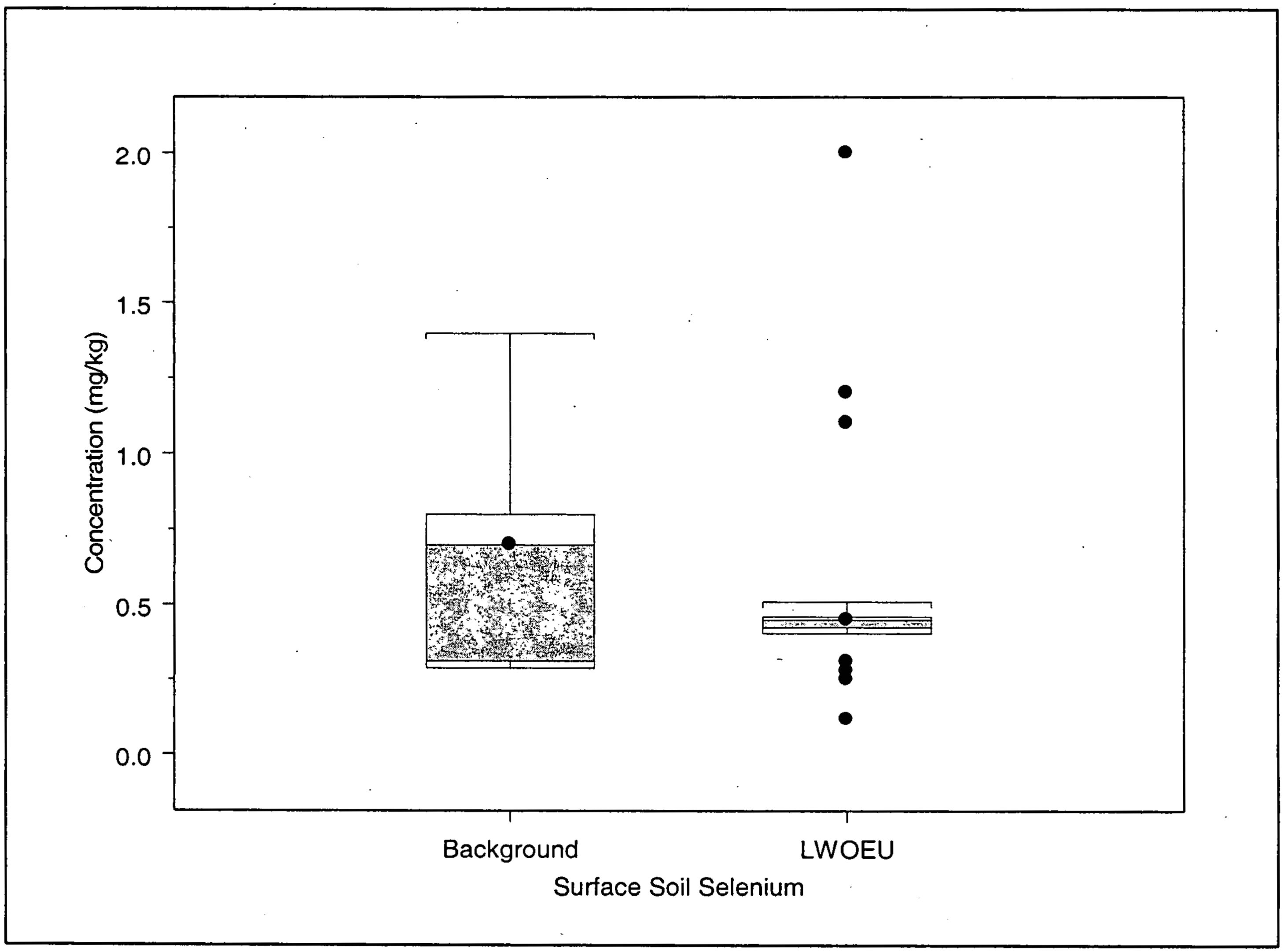
Figure [illegible].2.25
LWOEU Surface Soil Box Plots for Selenium



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

228

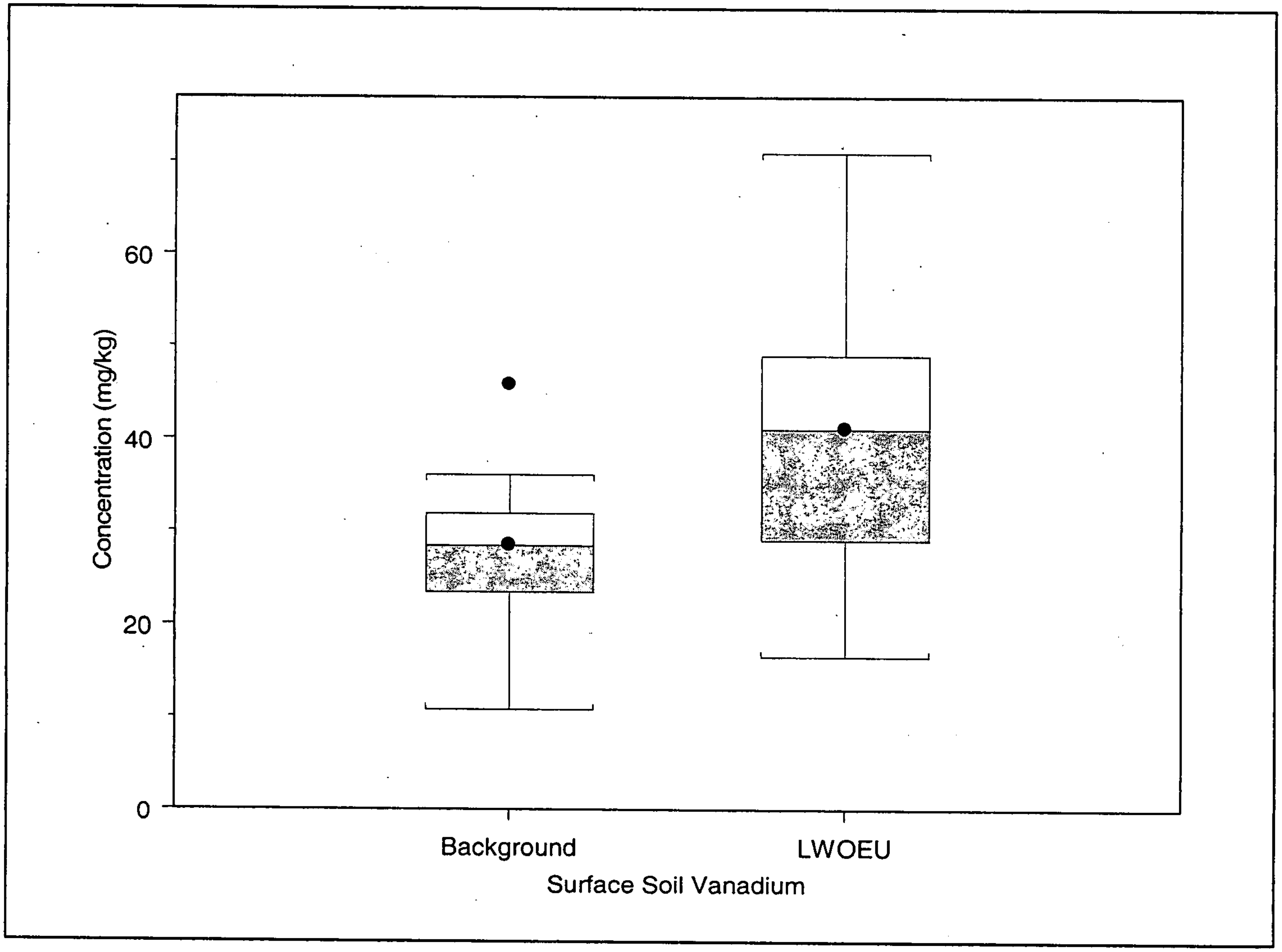
Figure [illegible].2.26
LWOEU Surface Soil (PMJM) Box Plots for Selenium



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

229

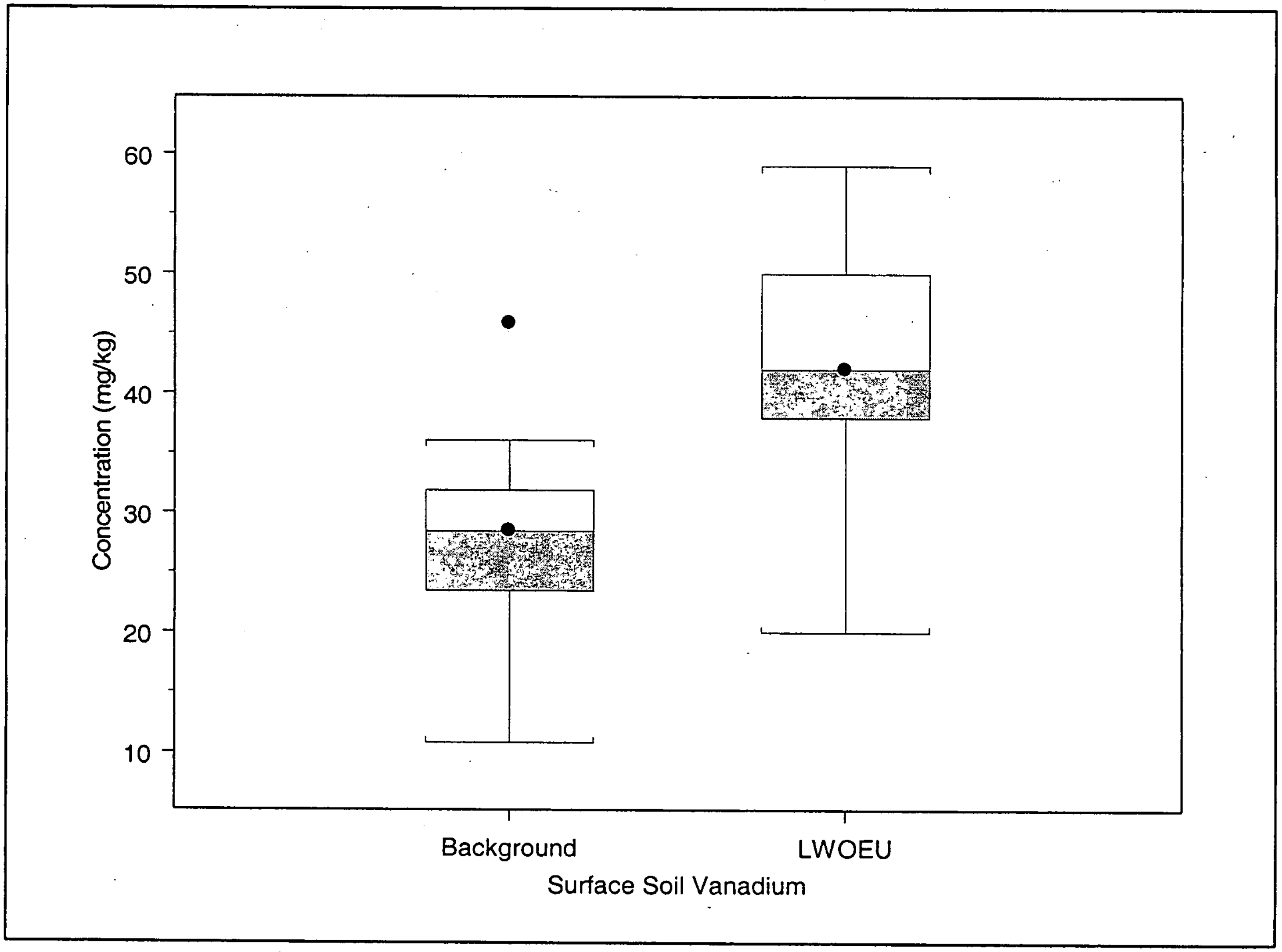
Figure A8.2.27
LWOEU Surface Soil Box Plots for Vanadium



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

230

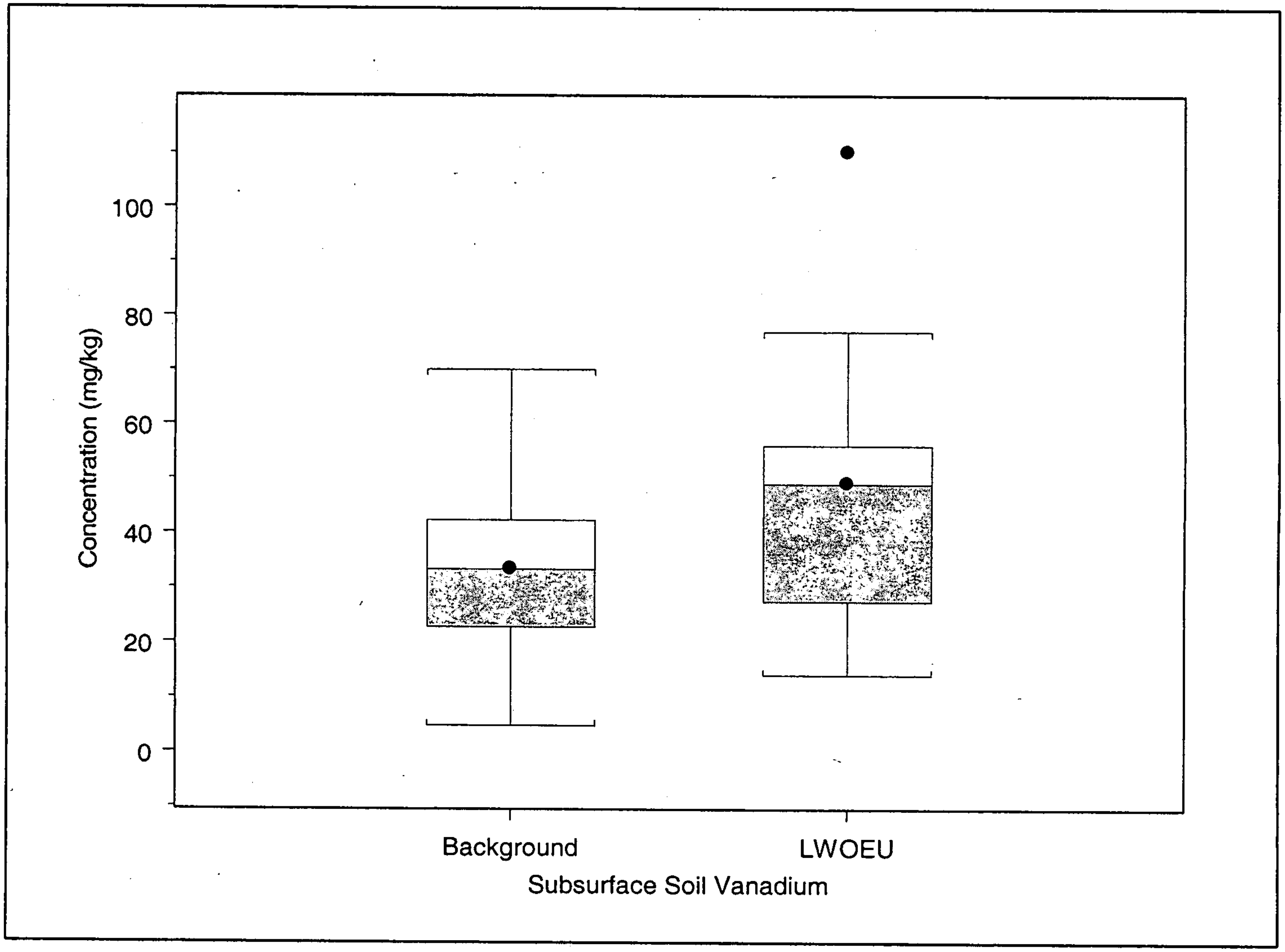
Figure A6.2.28
LWOEU Surface Soil (PMJM) Box Plots for Vanadium



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

231

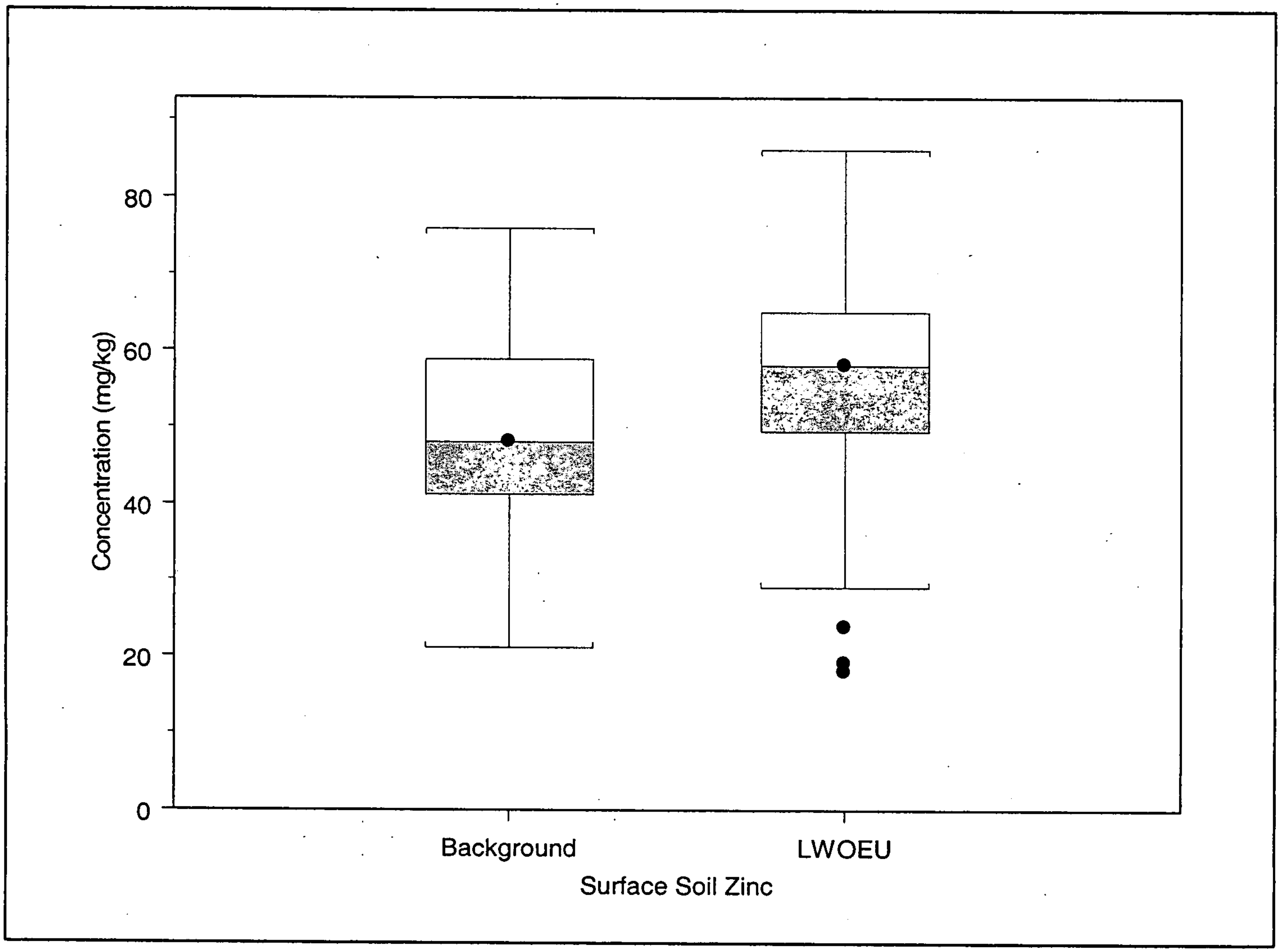
Figure A8.2.29
LWOEU Subsurface Soil Box Plots for Vanadium



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

232

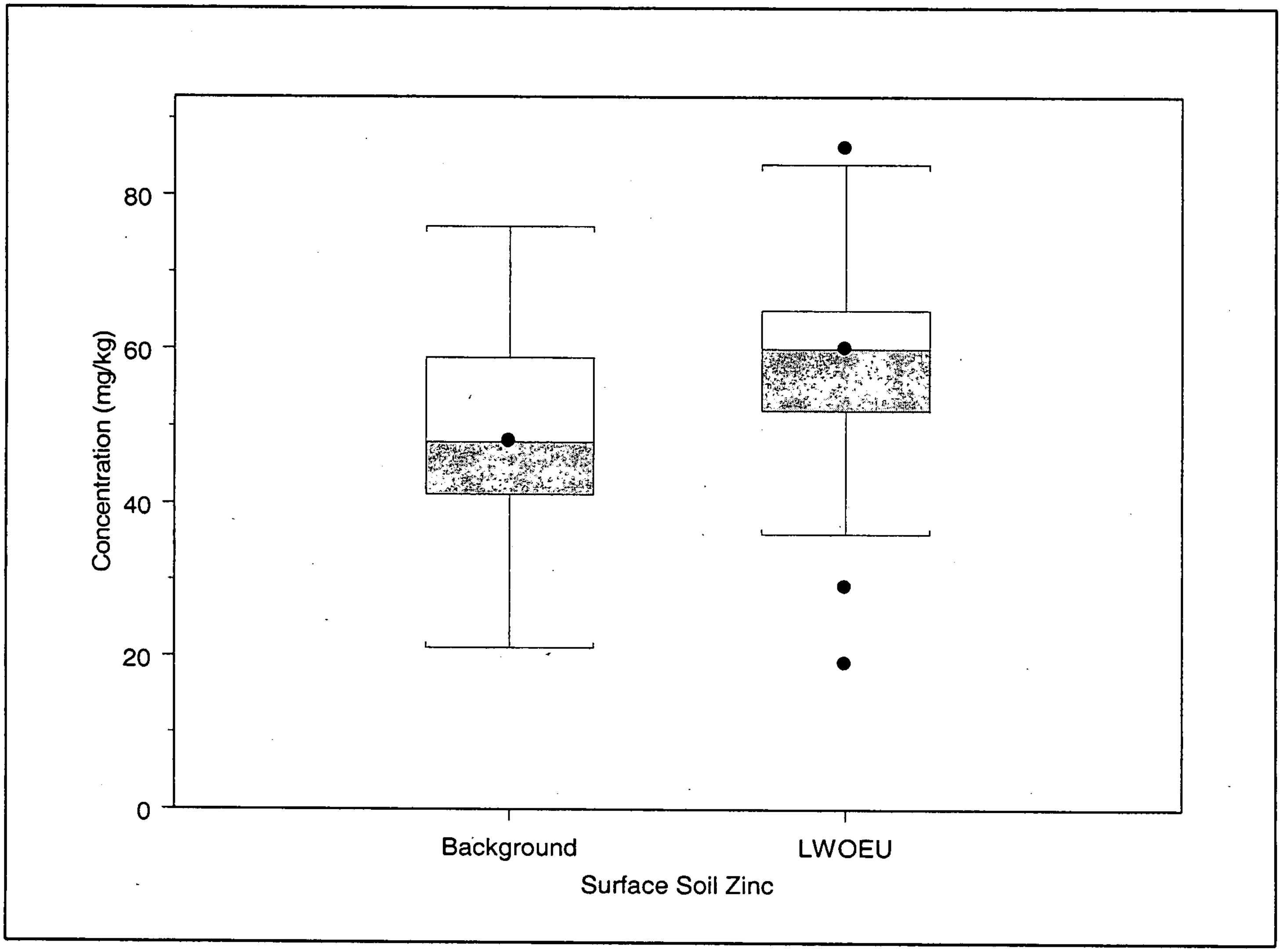
Figur[illegible].2.30
LWOEU Surface Soil Box Plots for Zinc



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

233

Figure A3.2.31
LWOEU Surface Soil (PMJM) Box Plots for Zinc



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

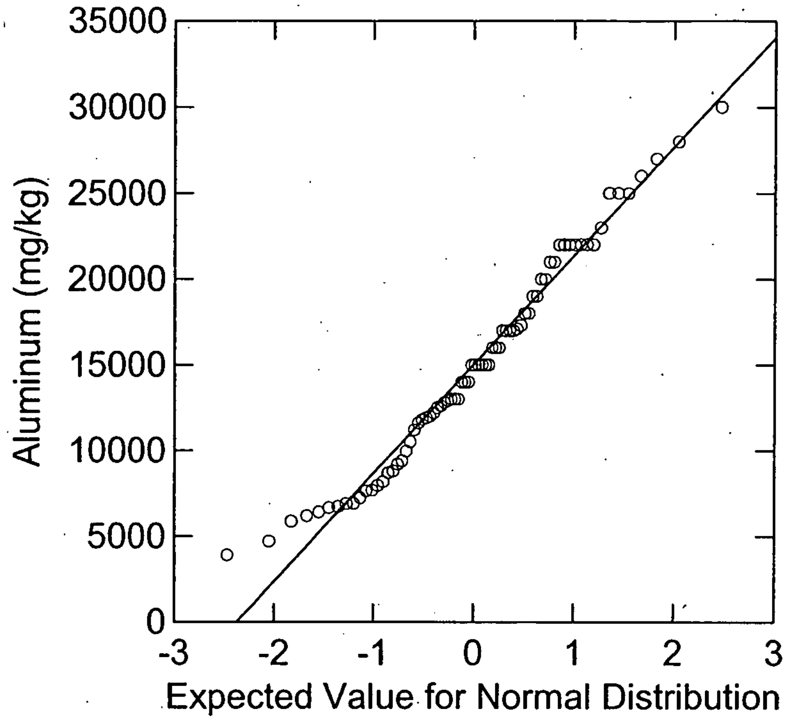


Figure A3.4.1 **Probability Plot of Aluminum Concentrations in LWOEU Surface Soil**

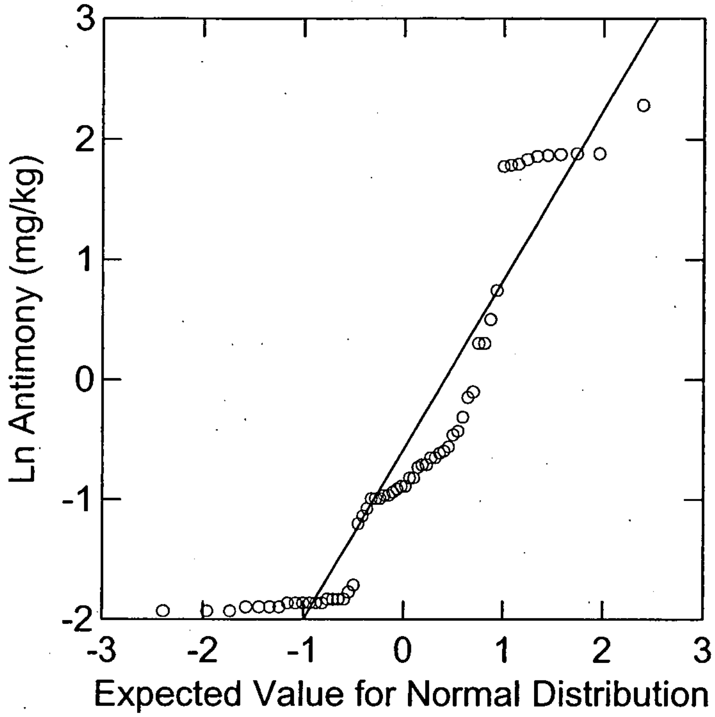


Figure A3.4.2 Probability Plot of Antimony Concentrations (Natural Logarithm) in LWOEU Surface Soil

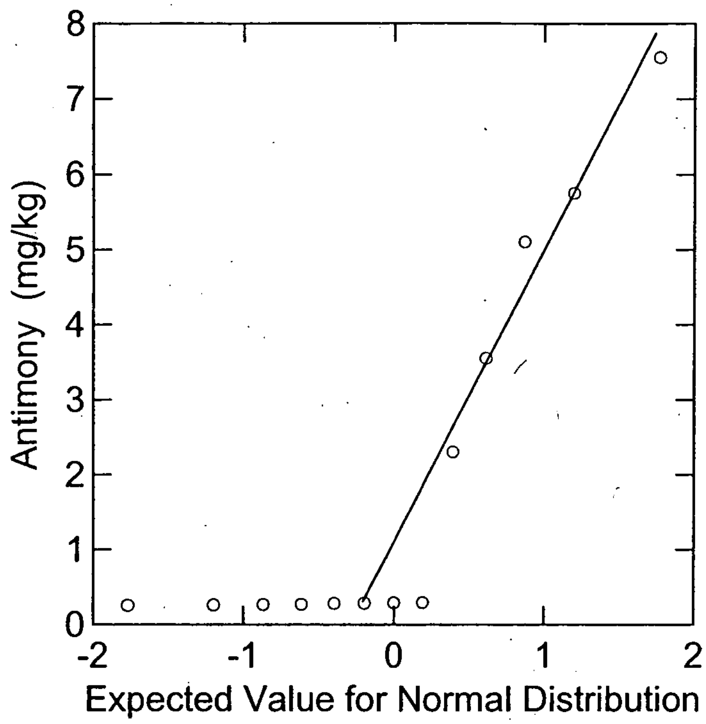


Figure A3.4.3 Probability Plot of Antimony Concentrations in LWOEU Subsurface Soil

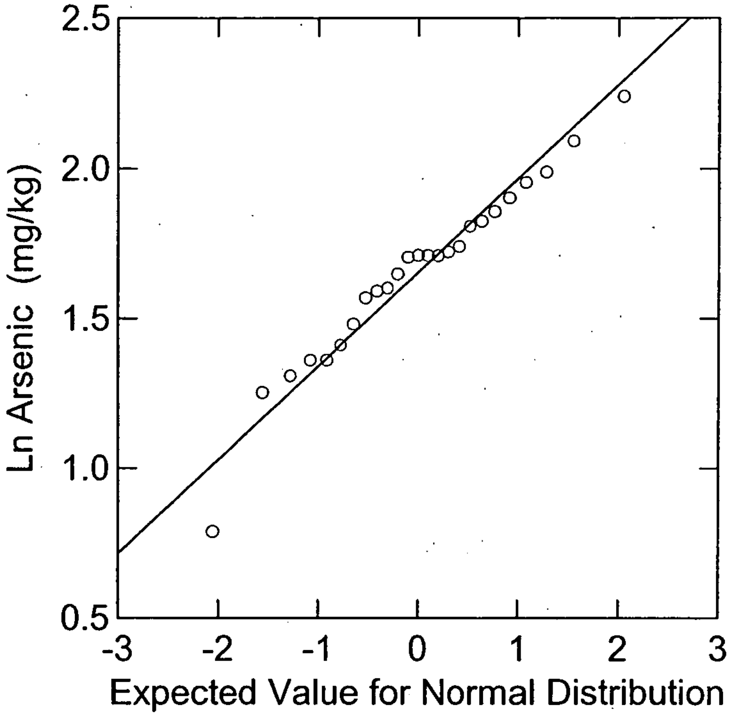


Figure A3.4.4 **Probability Plot of Arsenic Concentrations (Natural Logarithm) in LWOEU Surface Soil/Surface Sediment**

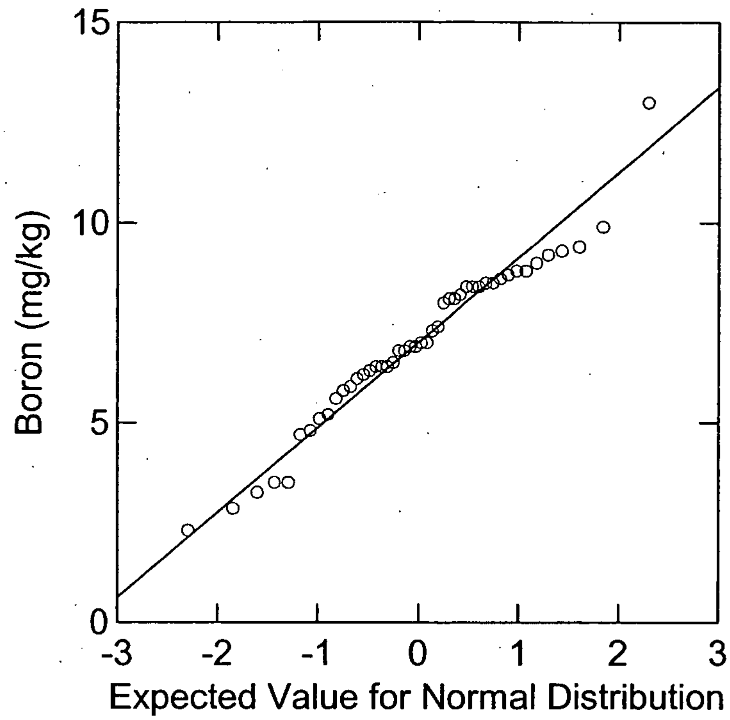


Figure A3.4.5 Probability Plot of Boron Concentrations in LWOEU Surface Soil

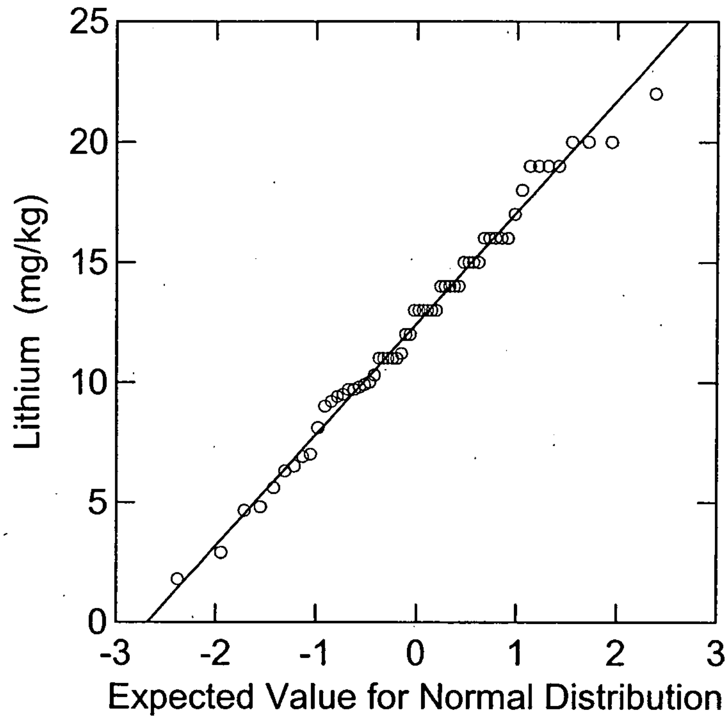


Figure A3.4.6 Probability Plot of Lithium Concentrations in LWOEU Surface Soil

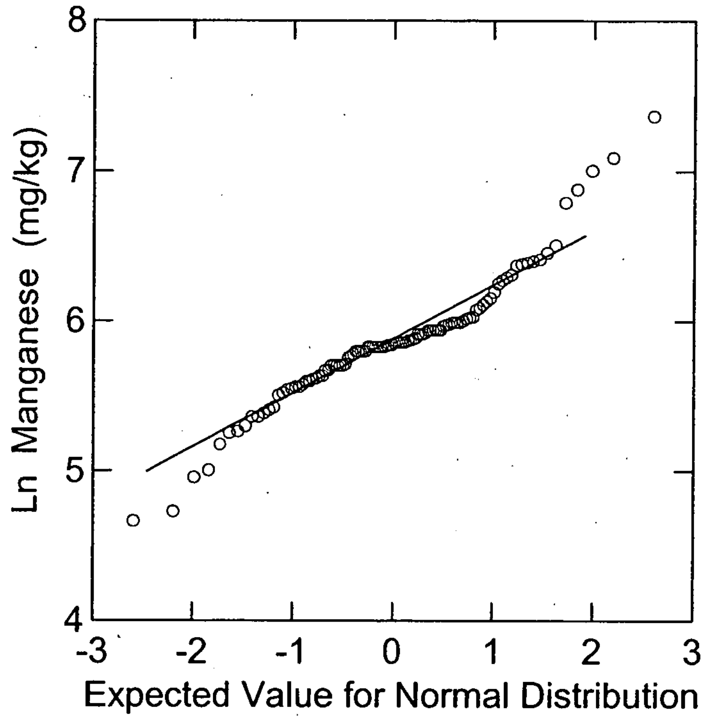


Figure A3.4.7 Probability Plot of Manganese Concentrations (Natural logarithm) in LWOEU Surface Soil/Surface Sediment

240

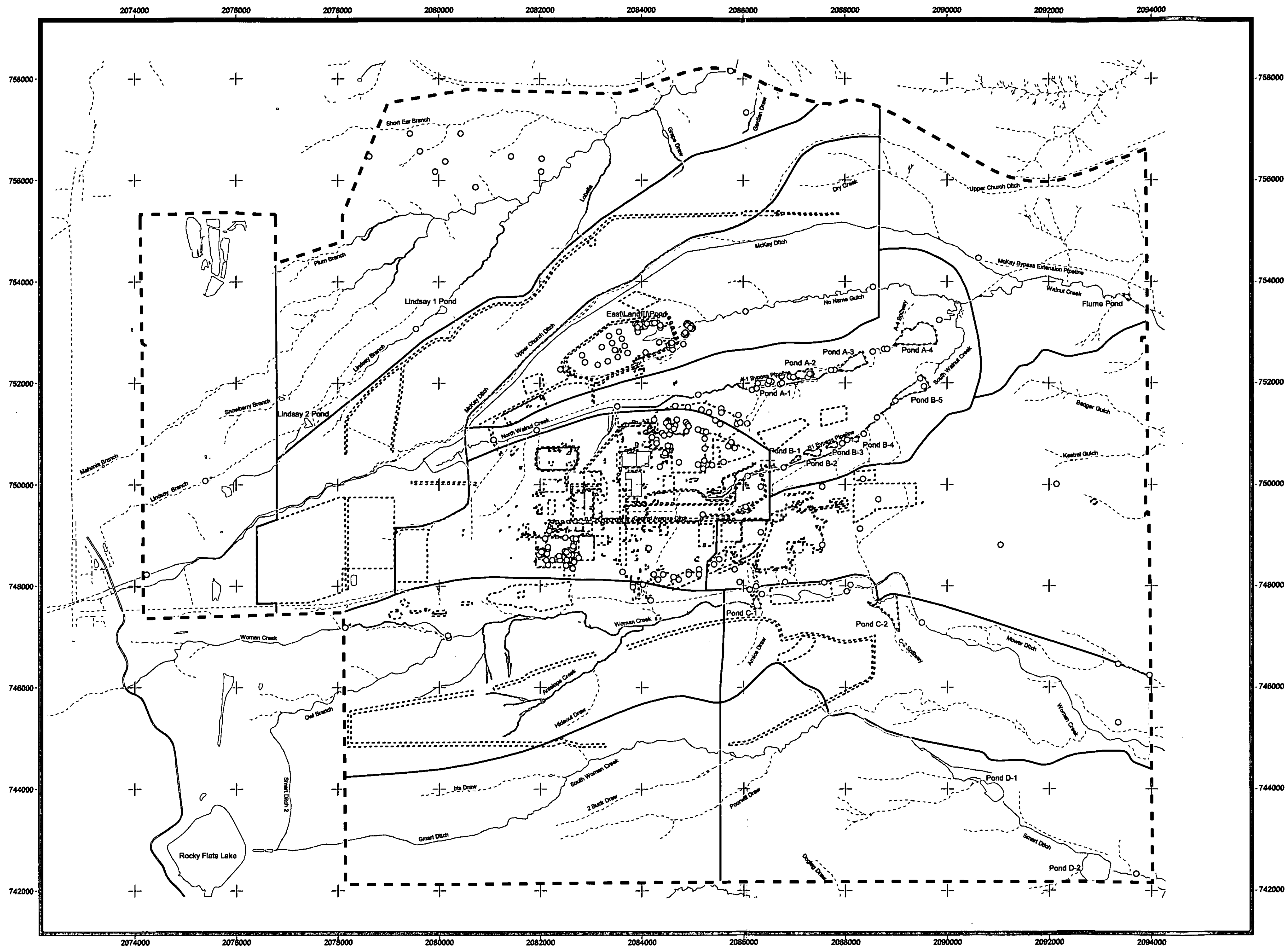


Figure A3.4.8

Radium-228 Concentrations in Sitewide Surface Soil/Surface Sediment

KEY

- O Concentration > 3x Background MDC
- O Concentration > Background MDC and <= 3x Background MDC
- O Concentration > WRW PRG and <= Background MDC
- O Concentration <= WRW PRG
- O Nondetect (ND)

WRW PRG = 0.111 pCi/g
Background MDC = 4.10 pCi/g
3 x Background MDC = 12.3 pCi/g

Standard Map Features

- Lower Woman Drainage EU
- Exposure Unit boundaries
- Former building where analyte was used or generated as waste
- Historical IHSS/PAC
- Pond
- Ephemeral stream
- Intermittent stream
- Perennial stream
- Site boundary

N W E S

0 1000 2000 Feet

Scale 1:24,000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental
Technology Site

File: W:\Projects\FY2005\CRA\ProfessionalJudgement\FINAL-profjudgment.apr

241

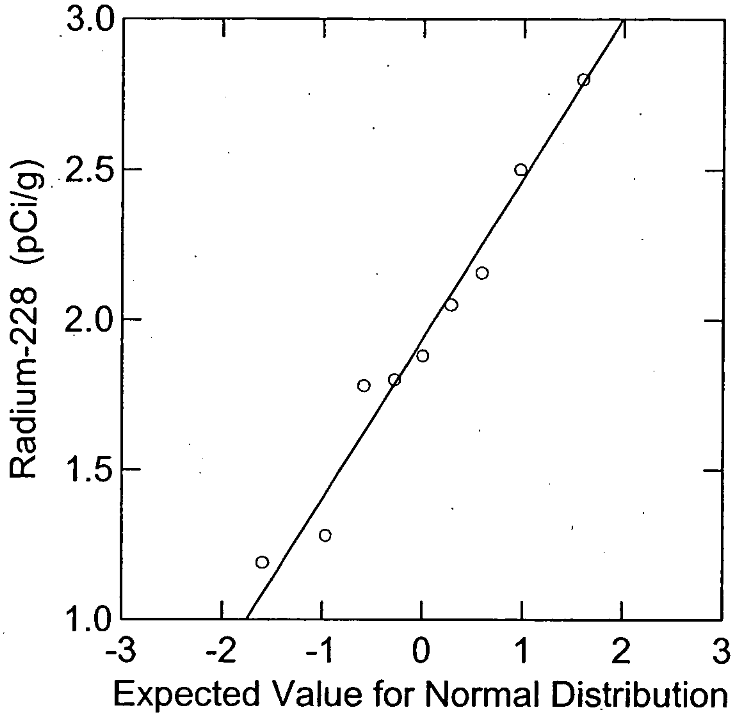


Figure A3.4.9 Probability Plot of Radium-228 Activities in LWOEU Surface Soil/Surface Sediment

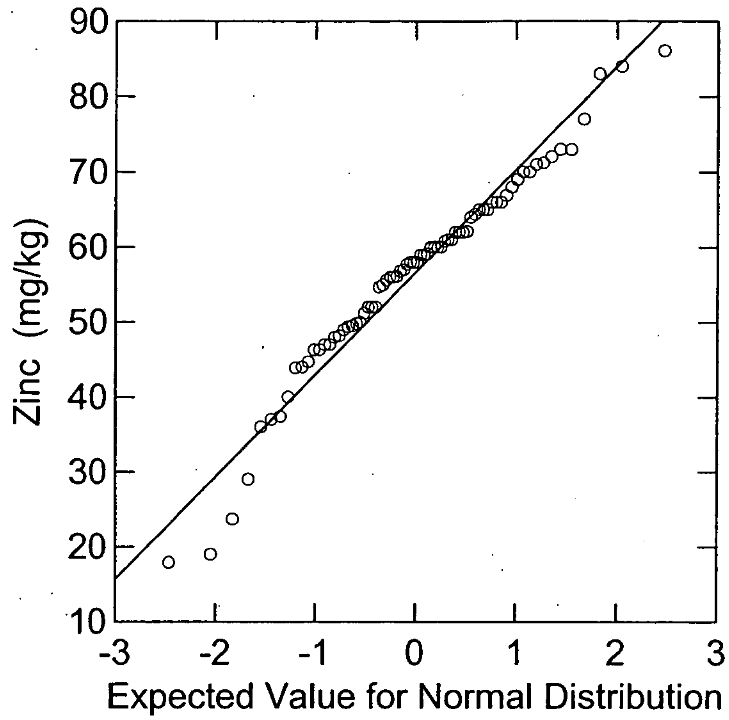


Figure A3.4.10 Probability Plot of Zinc Concentrations in LWOEU Surface Soil

COMPREHENSIVE RISK ASSESSMENT

LOWER WOMAN DRAINAGE EXPOSURE UNIT

VOLUME 11: ATTACHMENT 4

Risk Assessment Calculations

TABLE OF CONTENTS

Table A4.2.1	Intake and Exposure Estimates for Chromium – Default Exposure Scenario
Table A4.2.2	PMJM Intake and Exposure Estimates for Chromium – Default Exposure Scenario
Table A4.2.3	Intake and Exposure Estimates for Chromium – Alternative Exposure Scenario
Table A4.2.4	Terrestrial Plant Hazard Quotients for Surface Soils in the LWOEU – Chromium
Table A4.2.5	Terrestrial Invertebrate Hazard Quotients for Surface Soils in the LWOEU – Chromium
Table A4.2.6	Non-PMJM Receptor Hazard Quotient for Surface Soils in the LWOEU – Chromium
Table A4.2.7	PMJM Receptor Hazard Quotients for Surface Soils in LWOEU – Chromium
Table A4.2.8	Intake and Exposure Estimates for Copper – Default Exposure Scenario
Table A4.2.9	PMJM Intake Estimates for Copper – Default Exposure Scenario
Table A4.2.10	Non-PMJM Receptor Hazard Quotients for Surface Soils in the LWOEU – Copper
Table A4.2.11	PMJM Hazard Quotients for Surface Soils in LWOEU: Copper
Table A4.2.12	Intake and Exposure Estimates for Manganese – Default Exposure Scenario
Table A4.2.13	PMJM Receptor Intake and Exposure Estimates for Manganese – Default Exposure Scenario
Table A4.2.14	Terrestrial Plant Hazard Quotients for Surface Soils in the LWOEU – Manganese
Table A4.2.15	Non-PMJM Receptor Hazard Quotients for Surface Soils in the LWOEU – Manganese
Table A4.2.16	PMJM Receptor Hazard Quotients for Surface Soils in LWOEU – Manganese

245

Table A4.2.17 Intake and Exposure Estimates for Nickel – Default Exposure Scenario

Table A4.2.18 Intake and Exposure Estimates for Nickel – Alternative Exposure Scenario

Table A4.2.19 PMJM Receptor Intake and Exposure Estimates for Nickel – Default Exposure Scenario

Table A4.2.20 PMJM Intake Estimates for Nickel – Alternative Exposure Scenario

Table A4.2.21 Non-PMJM Receptor Hazard Quotients for Surface Soils in the LWOEU – Nickel

Table A4.2.22 PMJM Receptor Hazard Quotients for Surface Soils in LWOEU – Nickel

Table A4.2.23 Terrestrial Plant Hazard Quotients for Surface Soils in the LWOEU – Thallium

Table A4.2.24 Intake and Exposure Estimates for Tin – Default Exposure Scenario

Table A4.2.25 PMJM Receptor Intake and Exposure Estimates for Tin – Default Exposure Scenario

Table A4.2.26 Non-PMJM Receptor Hazard Quotients for Surface Soils in the LWOEU – Tin

Table A4.2.27 PMJM Receptor Hazard Quotients for Surface Soils in LWOEU – Tin

Table A4.2.28 Intake and Exposure Estimates for Vanadium – Default Exposure Scenario

Table A4.2.29 PMJM Receptor Intake and Exposure Estimates for Vanadium – Default Exposure Scenario

Table A4.2.30 Terrestrial Plant Hazard Quotients for Surface Soils in the LWOEU – Vanadium

Table A4.2.31 Non-PMJM Receptor Hazard Quotients for Surface Soils in the LWOEU – Vanadium

Table A4.2.32 PMJM Receptor Hazard Quotients for Surface Soils in LWOEU – Vanadium

Table A4.2.33 PMJM Receptor Intake and Exposure Estimates for Selenium – Default Exposure Scenario

Table A4.2.34 PMJM Receptor Hazard Quotients for Surface Soils in LWOEU – Selenium

Table A4.2.35 PMJM Receptor Intake and Exposure Estimates for Zinc – Default Exposure Scenario

Table A4.2.36 PMJM Receptor Hazard Quotients for Surface Soils in LWOEU – Zinc

247

Table A4.2.1
Intake and Exposure Estimates for Chromium - Default Exposure Scenario

Bioaccumulation Factors		
Soil to Plant	Soil to Invertebrate	Soil to Small Mammal
0.084	3.16	lnCm = -1.495 + 0.7326(lnCs)

		Media Concentrations (mg/kg)			
Soil Concentration	Statistic	Plant	Earthworm	Small Mammal	Surface Water (mg/L)
26.1	Tier 1 UTL	2.19	82.5	2.45	0.004
17.8	Tier 1 UCL	1.50	56.3	1.85	0.004
15.4	Tier 2 UTL	1.29	48.7	1.66	0.004
13.8	Tier 2 UCL	1.16	43.6	1.53	0.004

Intake Parameters	$IR_{(food)}$ (kg/kg BW day)	$IR_{(water)}$ (kg/kg BW day)	$IR_{(soil)}$ (kg/kg BW day)	P_{plant}	P_{invert}	P_{mammal}
Mourning Dove - Hervibore	0.23	0.12	0.021	1	0	0
Mourning Dove - Insectivore	0.23	0.12	0.021	0	1	0
American Kestrel	0.092	0.12	0.005	0	0.2	0.8
Deer Mouse - Insectivore	0.065	0.19	0.001	0	1	0

Intake Estimates (mg/kg BW day)	Plant Tissue	Invertebrate Tissue	Mammal Tissue	Soil	Surface Water	Total
Mourning Dove - Herbivore						
Tier 1 UTL	0.504	N/A	N/A	0.558	4.80E-04	1.06
Tier 1 UCL	0.344	N/A	N/A	0.381	4.80E-04	0.725
Tier 2 UTL	0.298	N/A	N/A	0.329	4.80E-04	0.627
Tier 2 UCL	0.267	N/A	N/A	0.295	4.80E-04	0.562
Mourning Dove - Insectivore						
Tier 1 UTL	N/A	19.0	N/A	0.558	4.80E-04	19.5
Tier 1 UCL	N/A	12.9	N/A	0.381	4.80E-04	13.3
Tier 2 UTL	N/A	11.2	N/A	0.329	4.80E-04	11.5
Tier 2 UCL	N/A	10.0	N/A	0.295	4.80E-04	10.3
American Kestrel						
Tier 1 UTL	N/A	1.52	0.180	0.120	4.80E-04	1.82
Tier 1 UCL	N/A	1.04	0.136	0.082	4.80E-04	1.25
Tier 2 UTL	N/A	0.896	0.122	0.071	4.80E-04	1.09
Tier 2 UCL	N/A	0.803	0.113	0.063	4.80E-04	0.980
Deer Mouse - Insectivore						
Tier 1 UTL	N/A	5.36	N/A	0.034	7.60E-04	5.40
Tier 1 UCL	N/A	3.66	N/A	0.023	7.60E-04	3.68
Tier 2 UTL	N/A	3.17	N/A	0.020	7.60E-04	3.19
Tier 2 UCL	N/A	2.84	N/A	0.018	7.60E-04	2.86

N/A = Not applicable or not available.

Table A4.2.2
PMJM Intake and Exposure Estimates for Chromium - Default Exposure Scenario

Bioaccumulation Factors						
Soil to Plant	Soil to Invertebrate	Soil to Small Mammal				
0.084	3.162	lnCm = -1.495 + 0.7326(lnCs)				
Media Concentrations (mg/kg)						
Patch	**Soil Concentration**	**Statistic**	**Plant**	**Earthworm**	**Small Mammal**	**Surface Water (mg/L)**
22	22	MDC	1.85	69.6	2.16	0.07
22	20	Mean	1.68	63.2	2.01	0.03
23	28	MDC	2.35	88.5	2.58	0.07
23	21	UCL	1.76	66.4	2.09	0.004
23	19.6	Mean	1.65	62.0	1.98	0.03
Intake Parameters						
	$IR_{(food)}$ (kg/kg BW day)	$IR_{(water)}$ (kg/kg BW day)	$IR_{(soil)}$ (kg/kg BW day)	P_{plant}	P_{invert}	P_{mammal}
PMJM	0.17	0.15	0.004	0.7	0.3	0
Intake Estimates (mg/kg BW day)						
	Plant Tissue	**Invertebrate Tissue**	**Mammal Tissue**	**Soil**	**Surface Water**	**Total**
Patch 22						
MDC	0.220	3.55	N/A	0.090	0.011	3.87
Mean	0.200	3.23	N/A	0.082	0.005	3.51
Patch 23						
MDC	0.280	4.52	N/A	0.114	0.011	4.92
UCL	0.210	3.39	N/A	0.086	6.00E-04	3.68
Mean	0.196	3.16	N/A	0.080	0.005	3.44

N/A = Not applicable or not available.

Table A4.2.3

Intake and Exposure Estimates for Chromium - Alternative Exposure Scenario

Bioaccumulation Factors (Median Values)						
Soil to Plant	Soil to Invertebrate	Soil to Small Mammal				
0.041	0.306	lnCm = -1.495 + 0.7326(lnCs)				
Media Concentrations (mg/kg)						
Soil Concentration	**Statistic**	**Plant**	**Earthworm**	**Small Mammal**	**Surface Water (mg/L)**	
26.1	Tier 1 UTL	1.07	8.0	2.45	0.004	
17.8	Tier 1 UCL	0.73	5.4	1.85	0.004	
15.4	Tier 2 UTL	0.63	4.7	1.66	0.004	
13.8	Tier 2 UCL	0.57	4.2	1.53	0.004	
Intake Parameters						
	$IR_{(food)}$ (kg/kg BW day)	$IR_{(water)}$ (kg/kg BW/day)	$IR_{(soil)}$ (kg/kg BW day)	P_{plant}	P_{invert}	P_{mammal}
Mourning Dove - Insectivore	0.23	0.12	0.021	0	1	0
Intake Estimates (mg/kg BW day)						
	Plant Tissue	**Invertebrate Tissue**	**Mammal Tissue**	**Soil**	**Surface Water**	**Total**
Mourning Dove - Insectivore						
Tier 1 UTL	N/A	1.84	N/A	0.558	4.80E-04	2.40
Tier 1 UCL	N/A	1.25	N/A	0.381	4.80E-04	1.63
Tier 2 UTL	N/A	1.08	N/A	0.329	4.80E-04	1.41
Tier 2 UCL	N/A	0.971	N/A	0.295	4.80E-04	1.27

N/A = Not applicable or not available

250

Table A4.2.4
Terrestrial Plant Hazard Quotients for Surface Soils in the LWOEU - Chromium

EPC Statistic	Concentration (mg/kg)	TRV (mg/kg BW day)			Hazard Quotients		
		Screening ESL	Alternate NOEC	Alternate LOEC	Screening ESL	Alternate NOEC	Alternate LOEC
Terrestrial Plant							
Tier 1 UTL	26.1	1.00	10.0	30.0	**26**	**3**	0.9
Tier 1 UCL	17.8	1.00	10.0	30.0	**18**	**2**	0.6
Tier 2 UTL	15.4	1.00	10.0	30.0	**15**	**2**	0.5
Tier 2 UCL	13.8	1.00	10.0	30.0	**14**	1	0.5

NA = Not applicable or not available.
Bold = Hazard quotients>1.

252

Table A4.2.5
Terrestrial Invertebrate Hazard Quotients for Surface Soils in the LWOEU - Chromium

EPC Statistic	Concentration (mg/kg)	TRV (mg/kg)		Hazard Quotients	
		Screening ESL	LOEC	Screening ESL	LOEC
Terrestrial Invertebrate					
Tier 1 UTL	26.1	0.400	32.6	**65**	0.8
Tier 1 UCL	17.8	0.400	32.6	**45**	0.5
Tier 2 UTL	15.4	0.400	32.6	**39**	0.5
Tier 2 UCL	13.8	0.400	32.6	**35**	0.4

Bold = Hazard quotients>1.

262

Table A4.2.6
Non-PMJM Receptor Hazard Quotients for Surface Soils in the LWOEU - Chromium

Receptor/ EPC Statistic	Total Intake (mg/kg BW day)	TRV (mg/kg BW day)				Hazard Quotients			
		Chromium VI NOAEL	Chromium VI LOAEL	Chromium III NOAEL	Chromium III LOAEL	Chromium VI NOAEL	Chromium VI LOAEL	Chromium III NOAEL	Chromium III LOAEL
Chromium (Default Exposure)									
Mourning Dove - Herbivore									
Tier 1 UTL	1.06	N/A	N/A	1.00	5.00	N/A	N/A	**1**	0.2
Tier 1 UCL	0.725	N/A	N/A	1.00	5.00	N/A	N/A	0.7	0.1
Tier 2 UTL	0.627	N/A	N/A	1.00	5.00	N/A	N/A	0.6	0.1
Tier 2 UCL	0.562	N/A	N/A	1.00	5.00	N/A	N/A	0.6	0.1
Mourning Dove - Insectivore									
Tier 1 UTL	19.5	N/A	N/A	1.00	5.00	N/A	N/A	**20**	**4**
Tier 1 UCL	13.3	N/A	N/A	1.00	5.00	N/A	N/A	**13**	**3**
Tier 2 UTL	11.5	N/A	N/A	1.00	5.00	N/A	N/A	**12**	**2**
Tier 2 UCL	10.3	N/A	N/A	1.00	5.00	N/A	N/A	**10**	**2**
American Kestrel									
Tier 1 UTL	1.82	N/A	N/A	1.00	5.00	N/A	N/A	**2**	0.4
Tier 1 UCL	1.25	N/A	N/A	1.00	5.00	N/A	N/A	1	0.3
Tier 2 UTL	1.09	N/A	N/A	1.00	5.00	N/A	N/A	1	0.2
Tier 2 UCL	0.980	N/A	N/A	1.00	5.00	N/A	N/A	1	0.2
Deer Mouse - Insectivore									
Tier 1 UTL	5.40	3.28	13.1	2,737	N/A	**2**	0.4	0.002	N/A
Tier 1 UCL	3.68	3.28	13.1	2,737	N/A	1	0.3	0.001	N/A
Tier 2 UTL	3.19	3.28	13.1	2,737	N/A	1	0.2	0.001	N/A
Tier 2 UCL	2.86	3.28	13.1	2,737	N/A	0.9	0.2	0.001	N/A
Chromium (Alternative Exposure Scenario; Median BAFs); Table 8.7									
Mourning Dove - Insectivore									
Tier 1 UTL	2.40	N/A	N/A	1.00	5.00	N/A	N/A	**2**	0.5
Tier 1 UCL	1.63	N/A	N/A	1.00	5.00	N/A	N/A	**2**	0.3
Tier 2 UTL	1.41	N/A	N/A	1.00	5.00	N/A	N/A	1	0.3
Tier 2 UCL	1.27	N/A	N/A	1.00	5.00	N/A	N/A	1	0.3

Bold = Hazard quotients>1.

253

Table A4.2.7
PMJM Receptor Hazard Quotients for Surface Soils in LWOEU - Chromium

Patch/ EPC Statistic	Total Intake (mg/kg BW day)	TRV (mg/kg BW day)			Hazard Quotients		
		Chromium VI NOAEL	Chromium VI LOAEL	Chromium III NOAEL	Chromium VI NOAEL	Chromium VI LOAEL	Chromium III NOAEL
Chromium (Default Exposure)							
Patch 22							
MDC	3.87	3.28	13.1	2,737	1	0.3	0.001
Mean	3.51	3.28	13.1	2,737	1	0.3	0.001
Patch 23							
MDC	4.92	3.28	13.1	2,737	1	0.4	0.002
UCL	3.68	3.28	13.1	2,737	1	0.3	0.001
Mean	3.44	3.28	13.1	2,737	1	0.3	0.001

N/A = Not applicable or not available.

Bold = Hazard quotients>1.

254

Table A4.2.8
Intake and Exposure Estimates for Copper - Default Exposure Scenario

Bioaccumulation Factors						
Soil to Plant	Soil to Invertebrate	Soil to Small Mammal				
lnCp = 0.669 + 0.394(lnCs)	lnCi = 1.675 + 0.264(lnCs)	lnCsm = 2.042 + .1444(lnCs)				
Media Concentrations (mg/kg)						
Soil Concentration	**Statistic**	**Plant**	**Earthworm**	**Small Mammal**	**Surface Water (mg/L)**	
30	Tier 1 UTL	7.46	13.10	12.59	0.007	
22.6	Tier 1 UCL	6.67	12.16	12.09	0.005	
18.7	Tier 2 UTL	6.19	11.57	11.76	0.007	
16.9	Tier 2 UCL	5.95	11.26	11.59	0.005	
Intake Parameters						
	$IR_{(food)}$ (kg/kg BW day)	**$IR_{(water)}$ (kg/kg BW day)**	**$IR_{(soil)}$ (kg/kg BW day)**	**P_{plant}**	**P_{invert}**	**P_{mammal}**
Mourning Dove - Hervibore	0.23	0.12	0.021	1	0	0
Mourning Dove - Insectivore	0.23	0.12	0.021	0	1	0
Intake Estimates (mg/kg BW day)						
	Plant Tissue	**Invertebrate Tissue**	**Mammal Tissue**	**Soil**	**Surface Water**	**Total**
Mourning Dove - Herbivore						
Tier 1 UTL	1.71	N/A	N/A	0.642	8.40E-04	2.36
Tier 1 UCL	1.53	N/A	N/A	0.483	6.00E-04	2.02
Tier 2 UTL	1.42	N/A	N/A	0.400	8.40E-04	1.82
Tier 2 UCL	1.37	N/A	N/A	0.361	6.00E-04	1.73
Mourning Dove - Insectivore						
Tier 1 UTL	N/A	3.01	N/A	0.642	8.40E-04	3.66
Tier 1 UCL	N/A	2.80	N/A	0.483	6.00E-04	3.28
Tier 2 UTL	N/A	2.66	N/A	0.400	8.40E-04	3.06
Tier 2 UCL	N/A	2.59	N/A	0.361	6.00E-04	2.95

N/A = Not applicable or not available.

255

Table A4.2.9
PMJM Intake Estimates for Copper - Default Exposure Scenario

Bioaccumulation Factors						
Soil to Plant	Soil to Invertebrate	Soil to Small Mammal				
lnCp = 0.669 + 0.394(lnCs)	lnCi = 1.675 + 0.264(lnCs)	Csm = 2.042 + .1444(lnCs)				
Media Concentrations (mg/kg)						
Patch	Soil Concentration	Statistic	Plant	Earthworm	Small Mammal	Surface Water (mg/L)
23	170	MDC	14.8	20.7	N/A	0.903
23	64.3	95th UTL	10.1	16.0	N/A	0.57
23	29	95th UCL	7.4	13.0	N/A	0.162
23	21.8	Mean	6.6	12.0	N/A	0.131
Intake Parameters						
	$IR_{(food)}$ (kg/kg BW day)	$IR_{(water)}$ (kg/kg BW day)	$IR_{(soil)}$ (kg/kg BW day)	P_{plant}	P_{invert}	P_{mammal}
PMJM	0.17	0.15	0.004	0.7	0.3	0
Intake Estimates (mg/kg BW day)						
	Plant Tissue	Invertebrate Tissue	Mammal Tissue	Soil	Surface Water	Total
Patch 23						
MDC	1.76E+00	1.06E+00	N/A	6.94E-01	1.35E-01	3.64E+00
95th UTL	1.20E+00	8.17E-01	N/A	2.62E-01	8.55E-02	2.36E+00
95th UCL	8.76E-01	6.62E-01	N/A	1.18E-01	2.43E-02	1.68E+00
Mean	7.82E-01	6.14E-01	N/A	8.89E-02	1.97E-02	1.51E+00

NA = Not applicable or not available.

256

Table A4.2.10
Non_PMJM Receptor Hazard Quotients for Surface Soils in the LWOEU - Copper

Receptor/-EPC Statistic	Total Intake (mg/kg BW day)	TRV (mg/kg BW day)			Hazard Quotients		
		NOAEL	Threshold	LOAEL	NOAEL	Threshold	LOAEL
Copper (Default Exposure)							
Mourning Dove - Herbivore							
Tier 1 UTL	2.36	2.30	11.0	52.3	1	0.2	0.05
Tier 1 UCL	2.02	2.30	11.0	52.3	0.9	0.2	0.04
Tier 2 UTL	1.82	2.30	11.0	52.3	0.8	0.2	0.03
Tier 2 UCL	1.73	2.30	11.0	52.3	0.8	0.2	0.03
Mourning Dove - Insectivore							
Tier 1 UTL	3.66	2.30	11.0	52.3	**2**	0.3	0.1
Tier 1 UCL	3.28	2.30	11.0	52.3	1	0.3	0.1
Tier 2 UTL	3.06	2.30	11.0	52.3	1	0.3	0.1
Tier 2 UCL	2.96	2.30	11.0	52.3	1	0.3	0.1

Bold = Hazard quotient>1.

Table A4.2.11
PMJM Hazard Quotients for Surface Soils in LWOEU: Copper

Patch/ EPC Statistic	Total Intake (mg/kg BW day)	TRV (mg/kg BW day)		Hazard Quotients	
		NOAEL	LOAEL	NOAEL	LOAEL
Copper (Default Exposure)					
Patch 23					
MDC	3.64E+00	2.67E+00	6.32E+02	1	0.01
95th UTL	2.36E+00	2.67E+00	6.32E+02	0.9	0.004
95th UCL	1.68E+00	2.67E+00	6.32E+02	0.6	0.003
Mean	1.51E+00	2.67E+00	6.32E+02	0.6	0.002

257

258

Table A4.2.12

Intake and Exposure Estimates for Manganese - Default Exposure Scenario

Bioaccumulation Factors						
Soil to Plant	Soil to Invertebrate	Soil to Small Mammal				
0.234	lnCi = 0.809 + 0.682(lnCs)	0.037				
Media Concentrations (mg/kg)						
Soil Concentration	**Statistic**	**Plant**	**Earthworm**	**Small Mammal**	**Surface Water (mg/L)**	
636	Tier 1 UTL	148.82	183.4	23.53	0.57	
408	Tier 1 UCL	95.47	135.5	15.10	0.162	
364.4	Tier 2 UTL	85.27	125.4	13.48	0.57	
340.1	Tier 2 UCL	79.58	119.6	12.58	0.162	
Intake Parameters						
	$IR_{(food)}$ (kg/kg BW day)	**$IR_{(water)}$ (kg/kg BW day)**	**$IR_{(soil)}$ (kg/kg BW day)**	**P_{plant}**	**P_{invert}**	**P_{mammal}**
Deer Mouse - Herbivore	0.111	0.19	0.002	1	0	0
Intake Estimates (mg/kg BW day)						
	Plant Tissue	**Invertebrate Tissue**	**Mammal Tissue**	**Soil**	**Surface Water**	**Total**
Deer Mouse - Herbivore						
Tier 1 UTL	16.5	N/A	N/A	1.41	0.108	18.0
Tier 1 UCL	10.6	N/A	N/A	0.906	0.031	11.5
Tier 2 UTL	9.46	N/A	N/A	0.809	0.108	10.4
Tier 2 UCL	8.83	N/A	N/A	0.755	0.031	9.62

N/A = Not applicable or not available.

259

Table A4.2.13

PMJM Receptor Intake and Exposure Estimates for Manganese - Default Exposure Scenario

Bioaccumulation Factors						
Soil to Plant	Soil to Invertebrate	Soil to Small Mammal				
0.234	lnCi = 0.809 + 0.682(lnCs)	0.037				
Media Concentrations (mg/kg)						
Patch	**Soil Concentration**	**Statistic**	**Plant**	**Earthworm**	**Small Mammal**	**Surface Water (mg/L)**
22	460	MDC	107.64	147.0	17.02	0.903
22	395	Mean	92.43	132.5	14.62	0.131
23	1200	MDC	280.80	282.7	44.40	0.903
23	764	UTL	178.78	207.8	28.27	0.57
23	475	UCL	111.15	150.3	17.58	0.162
23	420	Mean	98.28	138.2	15.54	0.131
27	596	MDC	139.46	175.4	22.05	0.903
27	463	Mean	108.34	147.7	17.13	0.131
Intake Parameters						
	$IR_{(food)}$ (kg/kg BW day)	$IR_{(water)}$ (kg/kg BW day)	$IR_{(soil)}$ (kg/kg BW day)	P_{plant}	P_{invert}	P_{mammal}
PMJM	0.17	0.15	0.004	0.7	0.3	0
Intake Estimates (mg/kg BW day)						
	Plant Tissue	**Invertebrate Tissue**	**Mammal Tissue**	**Soil**	**Surface Water**	**Total**
Patch 22						
MDC	12.8	7.50	N/A	1.88	0.135	22.3
Mean	11.0	6.76	N/A	1.61	0.020	19.4
Patch 23						
MDC	33.4	14.4	N/A	4.90	0.135	52.9
UTL	21.3	10.6	N/A	3.12	0.086	35.1
UCL	13.2	7.66	N/A	1.94	0.024	22.9
Mean	11.7	7.05	N/A	1.71	0.020	20.5
Patch 27						
MDC	16.6	8.95	N/A	2.43	0.135	28.1
Mean	12.9	7.53	N/A	1.89	0.020	22.3

N/A = Not applicable or not available.

Table A4.2.14
Terrestrial Plant Hazard Quotients for Surface Soils in the LWOEU - Manganese

EPC Statistic	Concentration (mg/kg)	TRV (mg/kg) Screening ESL	Hazard Quotients Screening ESL
Terrestrial Plant			
Tier 1 UTL	636	500	1
Tier 1 UCL	408	500	0.8
Tier 2 UTL	364	500	0.7
Tier 2 UCL	340	500	0.7

260

Table A4.2.15
Non-PMJM Receptor Hazard Quotients for Surface Soils in the LWOEU - Manganese

Receptor/EPC Statistic	Total Intake (mg/kg BW day)	TRV (mg/kg BW day)		Hazard Quotients	
		NOAEL	LOAEL	NOAEL	LOAEL
Manganese (Default Exposure)					
Deer Mouse - Herbivore					
Tier 1 UTL	18.0	13.3	159	1	0.1
Tier 1 UCL	11.5	13.3	159	0.9	0.1
Tier 2 UTL	10.4	13.3	159	0.8	0.1
Tier 2 UCL	9.62	13.3	159	0.7	0.1

Table A4.2.16

PMJM Receptor Hazard Quotients for Surface Soils in LWOEU - Manganese

Patch/ EPC Statistic	Total Intake (mg/kg BW day)	TRV (mg/kg BW day)		Hazard Quotients	
		NOAEL	LOAEL	NOAEL	LOAEL
Manganese (Default Exposure)					
Patch 22					
MDC	22.3	13.3	159	**2**	0.1
Mean	19.4	13.3	159	1	0.1
Patch 23					
MDC	52.9	13.3	159	**4**	0.3
UTL	35.1	13.3	159	**3**	0.2
UCL	22.9	13.3	159	**2**	0.1
Mean	20.5	13.3	159	**2**	0.1
Patch 27					
MDC	28.1	13.3	159	**2**	0.2
Mean	22.3	13.3	159	**2**	0.1

Bold = Hazard quotients>1.

263

Table A4.2.17
Intake and Exposure Estimates for Nickel - Default Exposure Scenario

Bioaccumulation Factors						
Soil to Plant	Soil to Invertebrate	Soil to Small Mammal				
lnCp = -2.224+0.748(lnCs)	4.73	lnCm = -0.2462 + 0.4658(lnCs)				
Media Concentrations (mg/kg)						
Soil Concentration	**Statistic**	**Plant**	**Earthworm**	**Small Mammal**	**Surface Water (mg/L)**	
23	Tier 1 UTL	1.13	108.8	3.37	0.01	
17	Tier 1 UCL	0.90	80.4	2.93	0.006	
15.6	Tier 2 UTL	0.84	73.8	2.81	0.01	
14.3	Tier 2 UCL	0.79	67.6	2.70	0.006	
Intake Parameters						
	$IR_{(food)}$ (kg/kg BW day)	$IR_{(water)}$ (kg/kg BW day)	$IR_{(soil)}$ (kg/kg BW day)	P_{plant}	P_{invert}	P_{mammal}
Mourning Dove - Insectivore	0.23	0.12	0.021	0	1	0
Deer Mouse - Herbivore	0.111	0.19	0.002	1	0	0
Deer Mouse - Insectivore	0.065	0.19	0.001	0	1	0
Coyote - Generalist	0.015	0.08	0.001	0	0.25	0.75
Coyote - Insectivore	0.015	0.08	0.0004	0	1	0
Intake Estimates (mg/kg BW day)						
	Plant Tissue	**Invertebrate Tissue**	**Mammal Tissue**	**Soil**	**Surface Water**	**Total**
Mourning Dove - Insectivore						
Tier 1 UTL	N/A	25.0	N/A	0.492	0.001	25.5
Tier 1 UCL	N/A	18.5	N/A	0.364	7.20E-04	18.9
Tier 2 UTL	N/A	17.0	N/A	0.334	0.001	17.3
Tier 2 UCL	N/A	15.6	N/A	0.306	7.20E-04	15.9
Deer Mouse - Herbivore						
Tier 1 UTL	0.125	N/A	N/A	0.051	0.002	0.178
Tier 1 UCL	0.100	N/A	N/A	0.038	0.001	0.139
Tier 2 UTL	0.094	N/A	N/A	0.035	0.002	0.130
Tier 2 UCL	0.088	N/A	N/A	0.032	0.001	0.121
Deer Mouse - Insectivore						
Tier 1 UTL	N/A	7.07	N/A	0.030	0.002	7.10
Tier 1 UCL	N/A	5.23	N/A	0.022	0.001	5.25
Tier 2 UTL	N/A	4.80	N/A	0.020	0.002	4.82
Tier 2 UCL	N/A	4.40	N/A	0.019	0.001	4.42

264

Table A4.2.17

Intake and Exposure Estimates for Nickel - Default Exposure Scenario

	Intake Estimates (mg/kg BW day)					
	Plant Tissue	Invertebrate Tissue	Mammal Tissue	Soil	Surface Water	Total
Coyote - Generalist						
Tier 1 UTL	N/A	0.408	0.038	0.017	8.00E-04	0.464
Tier 1 UCL	N/A	0.302	0.033	0.013	4.80E-04	0.348
Tier 2 UTL	N/A	0.277	0.032	0.012	8.00E-04	0.321
Tier 2 UCL	N/A	0.254	0.030	0.011	4.80E-04	0.295
Coyote - Insectivore						
Tier 1 UTL	N/A	1.63	N/A	0.010	8.00E-04	1.64
Tier 1 UCL	N/A	1.21	N/A	0.007	4.80E-04	1.21
Tier 2 UTL	N/A	1.11	N/A	0.007	8.00E-04	1.11
Tier 2 UCL	N/A	1.01	N/A	0.006	4.80E-04	1.02

N/A = Not applicable or not available.

265

Table A4.2.18
Intake and Exposure Estimates for Nickel - Alternative Exposure Scenario

Bioaccumulation Factors (Median Values)						
Soil to Plant	Soil to Invertebrate	Soil to Small Mammal				
$\ln Cp = -2.224+0.748(\ln Cs)$	1.059	$\ln Cm = -0.2462 + 0.4658(\ln Cs)$				
Media Concentrations (mg/kg)						
Soil Concentration	**Statistic**	**Plant**	**Earthworm**	**Small Mammal**	**Surface Water (mg/L)**	
23	Tier 1 UTL	1.13	24.4	3.37	0.01	
17	Tier 1 UCL	0.90	18.0	2.93	0.006	
15.6	Tier 2 UTL	0.84	16.5	2.81	0.01	
14.3	Tier 2 UCL	0.79	15.1	2.70	0.006	
Intake Parameters						
	$IR_{(food)}$ (kg/kg BW day)	$IR_{(water)}$ (kg/kg BW day)	$IR_{(soil)}$ (kg/kg BW day)	P_{plant}	P_{invert}	P_{mammal}
Deer Mouse - Insectivore	0.065	0.19	0.001	0	1	0
Intake Estimates (mg/kg BW day)						
	Plant Tissue	**Invertebrate Tissue**	**Mammal Tissue**	**Soil**	**Surface Water**	**Total**
Deer Mouse - Insectivore						
Tier 1 UTL	N/A	1.58	N/A	0.030	0.002	1.62
Tier 1 UCL	N/A	1.17	N/A	0.022	0.001	1.19
Tier 2 UTL	N/A	1.07	N/A	0.020	0.002	1.10
Tier 2 UCL	N/A	0.984	N/A	0.019	0.001	1.00

N/A = Not applicable or not available.

266

Table A4.2.19

PMJM Receptor Intake and Exposure Estimates for Nickel - Default Exposure Scenario

Bioaccumulation Factors						
Soil to Plant	Soil to Invertebrate	Soil to Small Mammal				
$\ln Cp = -2.224+0.748(\ln Cs)$	4.73	$\ln Cm = -0.2462 + 0.4658(\ln Cs)$				
Media Concentrations (mg/kg)						
Patch	**Soil Concentration**	**Statistic**	**Plant**	**Earthworm**	**Small Mammal**	**Surface Water (mg/L)**
22	19	MDC	0.98	89.9	3.08	0.02
22	18.5	Mean	0.96	87.5	3.04	0.004
23	25	MDC	1.20	118.3	3.50	0.02
23	23.3	UTL	1.14	110.2	3.39	0.01
23	17.9	UCL	0.94	84.7	3.00	0.006
23	16.9	Mean	0.90	79.9	2.92	0.004
24	15	MDC	0.82	71.0	2.76	0.02
27	45.2	MDC	1.87	213.8	4.61	0.02
27	27.65	Mean	1.30	130.8	3.67	0.004
Intake Parameters						
	$IR_{(food)}$ (kg/kg BW day)	**$IR_{(water)}$ (kg/kg BW day)**	**$IR_{(soil)}$ (kg/kg BW day)**	**P_{plant}**	**P_{invert}**	**P_{mammal}**
PMJM	0.17	0.15	0.004	0.7	0.3	0
Intake Estimates (mg/kg BW day)						
	Plant Tissue	**Invertebrate Tissue**	**Mammal Tissue**	**Soil**	**Surface Water**	**Total**
Patch 22						
MDC	0.116	4.58	N/A	0.078	0.003	4.78
Mean	0.114	4.46	N/A	0.075	6.00E-04	4.65
Patch 23						
MDC	0.143	6.03	N/A	0.102	0.003	6.28
UTL	0.136	5.62	N/A	0.095	0.002	5.85
UCL	0.111	4.32	N/A	0.073	9.00E-04	4.50
Mean	0.107	4.08	N/A	0.069	6.00E-04	4.25
Patch 24						
MDC	0.098	3.62	N/A	0.061	0.003	3.78
Patch 27						
MDC	0.223	10.9	N/A	0.184	0.003	11.3
Mean	0.154	6.67	N/A	0.113	6.00E-04	6.94

N/A = Not applicable or not available.

267

Table A4.2.20
PMJM Intake Estimates for Nickel - Alternative Exposure Scenario

Bioaccumulation Factors (Median Values)						
Soil to Plant	Soil to Invertebrate	Soil to Small Mammal				
lnCp = -2.224+0.748(lnCs)	1.059	lnCm = -0.2462 + 0.4658(lnCs)				
Media Concentrations (mg/kg)						
Patch	**Soil Concentration**	**Statistic**	**Plant**	**Earthworm**	**Small Mammal**	**Surface Water (mg/L)**
22	19	MDC	0.98	20.1	3.08	0.02
22	18.5	Mean	0.96	19.6	3.04	0.004
23	25	MDC	1.20	26.5	3.50	0.02
23	23.3	UTL	1.14	24.7	3.39	0.01
23	17.9	UCL	0.94	19.0	3.00	0.006
23	16.9	Mean	0.90	17.9	2.92	0.004
24	15	MDC	0.82	15.9	2.76	0.02
27	45.2	MDC	1.87	47.9	4.61	0.02
27	27.65	Mean	1.30	29.3	3.67	0.004
Intake Parameters						
	$IR_{(food)}$ (kg/kg BW day)	$IR_{(water)}$ (kg/kg BW day)	$IR_{(soil)}$ (kg/kg BW day)	P_{plant}	P_{invert}	P_{mammal}
PMJM	0.17	0.15	0.004	0.7	0.3	0
Intake Estimates (mg/kg BW day)						
	Plant Tissue	**Invertebrate Tissue**	**Mammal Tissue**	**Soil**	**Surface Water**	**Total**
Patch 22						
MDC	0.116	1.03	N/A	0.078	0.003	1.22
Mean	0.114	0.999	N/A	0.075	6.00E-04	1.19
Patch 23						
MDC	0.143	1.35	N/A	0.102	0.003	1.60
UTL	0.136	1.26	N/A	0.095	0.002	1.49
UCL	0.111	0.967	N/A	0.073	9.00E-04	1.15
Mean	0.107	0.913	N/A	0.069	6.00E-04	1.09
Patch 24						
MDC	0.098	0.810	N/A	0.061	0.003	0.972
Patch 27						
MDC	0.223	2.44	N/A	0.184	0.003	2.85
Mean	0.154	1.49	N/A	0.113	6.00E-04	1.76

N/A = Not applicable or not available.

Table A4.2.21
Non-PMJM Receptor Hazard Quotients for Surface Soils in the LWOEU - Nickel

Receptor/ EPC Statistic	Total Intake (mg/kg BW day)	TRV (mg/kg BW day)					Hazard Quotients				
		NOAEL	Threshold	LOAEL	Sample et al. (1996) NOAEL	Sample et al. (1996) LOAEL	NOAEL	Threshold	LOAEL	Sample et al. (1996) NOAEL	Sample et al. (1996) LOAEL
Nickel (Default Exposure)											
Mourning Dove - Insectivore											
Tier 1 UTL	25.5	1.38	8.70	55.3	N/A	N/A	**18**	**3**	0.5	N/A	N/A
Tier 1 UCL	18.9	1.38	8.70	55.3	N/A	N/A	**14**	**2**	0.3	N/A	N/A
Tier 2 UTL	17.3	1.38	8.70	55.3	N/A	N/A	**13**	**2**	0.3	N/A	N/A
Tier 2 UCL	15.9	1.38	8.70	55.3	N/A	N/A	**11**	**2**	0.3	N/A	N/A
Deer Mouse - Herbivore											
Tier 1 UTL	0.178	0.133	N/A	1.33	N/A	N/A	1	N/A	0.1	N/A	N/A
Tier 1 UCL	0.139	0.133	N/A	1.33	N/A	N/A	1	N/A	0.1	N/A	N/A
Tier 2 UTL	0.130	0.133	N/A	1.33	N/A	N/A	0.98	N/A	0.1	N/A	N/A
Tier 2 UCL	0.121	0.133	N/A	1.33	N/A	N/A	0.9	N/A	0.1	N/A	N/A
Deer Mouse - Insectivore											
Tier 1 UTL	7.10	0.133	N/A	1.33	40.0	80.0	**53**	N/A	**5**	0.2	N/A
Tier 1 UCL	5.25	0.133	N/A	1.33	40.0	80.0	**39**	N/A	**4**	0.1	N/A
Tier 2 UTL	4.82	0.133	N/A	1.33	40.0	80.0	**36**	N/A	**4**	0.1	N/A
Tier 2 UCL	4.42	0.133	N/A	1.33	40.0	80.0	**33**	N/A	**3**	0.1	N/A
Coyote - Generalist											
Tier 1 UTL	0.464	0.133	N/A	1.33	N/A	N/A	**3**	N/A	0.3	N/A	N/A
Tier 1 UCL	0.348	0.133	N/A	1.33	N/A	N/A	**3**	N/A	0.3	N/A	N/A
Tier 2 UTL	0.321	0.133	N/A	1.33	N/A	N/A	**2**	N/A	0.2	N/A	N/A
Tier 2 UCL	0.295	0.133	N/A	1.33	N/A	N/A	**2**	N/A	0.2	N/A	N/A
Coyote - Insectivore											
Tier 1 UTL	1.64	0.133	N/A	1.33	N/A	N/A	**12**	N/A	1	N/A	N/A
Tier 1 UCL	1.21	0.133	N/A	1.33	N/A	N/A	**9**	N/A	0.9	N/A	N/A
Tier 2 UTL	1.11	0.133	N/A	1.33	N/A	N/A	**8**	N/A	0.8	N/A	N/A
Tier 2 UCL	1.02	0.133	N/A	1.33	N/A	N/A	**8**	N/A	0.8	N/A	N/A
Nickel (Alternative Exposure Scenario; Median BAFs)											
Deer Mouse - Insectivore											
Tier 1 UTL	1.62	0.133	N/A	1.33	40.0	80.0	**12**	N/A	1	N/A	0.02
Tier 1 UCL	1.19	0.133	N/A	1.33	40.0	80.0	**9**	N/A	0.9	N/A	0.01
Tier 2 UTL	1.10	0.133	N/A	1.33	40.0	80.0	**8**	N/A	0.8	N/A	0.01
Tier 2 UCL	1.00	0.133	N/A	1.33	40.0	80.0	**8**	N/A	0.8	N/A	0.01

N/A = Not applicable or not available.
Bold = Hazard quotients>1.

269

Table A4.2.22

PMJM Receptor Hazard Quotients for Surface Soils in LWOEU - Nickel

Patch/ EPC Statistic	Total Intake (mg/kg BW day)	TRV (mg/kg BW day)				Hazard Quotients			
		NOAEL	LOAEL	Sample et al. (1996) NOAEL	Sample et al. (1996) LOAEL	NOAEL	LOAEL	Sample et al. (1996) NOAEL	Sample et al. (1996) LOAEL
Nickel (Default Exposure)									
Patch 22									
MDC	4.78	0.133	1.33	40.0	80.0	**36**	**4**	0.1	0.1
Mean	4.65	0.133	1.33	40.0	80.0	**35**	**3**	0.1	0.1
Patch 23									
MDC	6.28	0.133	1.33	40.0	80.0	**47**	**5**	0.2	0.1
UTL	5.85	0.133	1.33	40.0	80.0	**44**	**4**	0.1	0.1
UCL	4.50	0.133	1.33	40.0	80.0	**34**	**3**	0.1	0.1
Mean	4.25	0.133	1.33	40.0	80.0	**32**	**3**	0.1	0.1
Patch 24									
MDC	3.78	0.133	1.33	40.0	80.0	**28**	**3**	0.1	0.05
Patch 27									
MDC	11.3	0.133	1.33	40.0	80.0	**85**	**9**	0.3	0.1
Mean	6.94	0.133	1.33	40.0	80.0	**52**	**5**	0.2	0.1
Nickel (Alternative Exposure Scenario; Median BAFs)									
Patch 22									
MDC	1.22	0.133	1.33	40.0	80.0	**9**	0.9	0.03	0.02
Mean	1.19	0.133	1.33	40.0	80.0	**9**	0.9	0.03	0.01
Patch 23									
MDC	1.60	0.133	1.33	40.0	80.0	**12**	1	0.04	0.02
UTL	1.49	0.133	1.33	40.0	80.0	**11**	1	0.04	0.02
UCL	1.15	0.133	1.33	40.0	80.0	**9**	0.9	0.03	0.01
Mean	1.09	0.133	1.33	40.0	80.0	**8**	0.8	0.03	0.01
Patch 24									
MDC	0.972	0.133	1.33	40.0	80.0	**7**	0.7	0.02	0.01
Patch 27									
MDC	2.85	0.133	1.33	40.0	80.0	**21**	**2**	0.1	0.04
Mean	1.76	0.133	1.33	40.0	80.0	**13**	1	0.04	0.02

N/A = Not applicable or not available.

Bold = Hazard quotients>1.

Table A4.2.23
Terrestrial Plant Hazard Quotients for Surface Soils in the LWOEU - Thallium

EPC Statistic	Concentration (mg/kg)	TRV (mg/kg) Screening ESL	Hazard Quotients Screening ESL
Terrestrial Plant			
Tier 1 UTL	2.1	1.00	**2**
Tier 1 UCL	1.61	1.00	**2**
Tier 2 UTL	0.431	1.00	0.4
Tier 2 UCL	0.354	1.00	0.4

Bold = Hazard quotients>1.

270

271

Table 4.2.24
Intake and Exposure Estimates for Tin - Default Exposure Scenario

Bioaccumulation Factors						
Soil to Plant	Soil to Invertebrate	Soil to Small Mammal				
0.03	1	0.21				
Media Concentrations (mg/kg)						
Soil Concentration	Statistic	Plant	Earthworm	Small Mammal	Surface Water (mg/L)	
29.1	Tier 1 UTL	0.87	29.10	6.11	0.019	
15.4	Tier 1 UCL	0.46	15.43	3.24	0.009	
12.8	Tier 2 UTL	0.38	12.77	2.68	0.019	
9.37	Tier 2 UCL	0.28	9.37	1.97	0.009	
Intake Parameters						
	$IR_{(food)}$ (kg/kg BW day)	$IR_{(water)}$ (kg/kg BW day)	$IR_{(soil)}$ (kg/kg BW day)	P_{plant}	P_{invert}	P_{mammal}
Mourning Dove - Hervibore	0.23	0.12	0.021	1	0	0
Mourning Dove - Insectivore	0.23	0.12	0.021	0	1	0
American Kestrel	0.092	0.12	0.005	0	0.2	0.8
Deer Mouse - Insectivore	0.065	0.19	0.001	0	1	0
Intake Estimates (mg/kg BW day)						
	Plant Tissue	Invertebrate Tissue	Mammal Tissue	Soil	Surface Water	Total
Mourning Dove - Herbivore						
Tier 1 UTL	0.201	N/A	N/A	0.622	0.002	0.826
Tier 1 UCL	0.106	N/A	N/A	0.330	0.001	0.438
Tier 2 UTL	0.088	N/A	N/A	0.273	0.002	0.364
Tier 2 UCL	0.065	N/A	N/A	0.200	0.001	0.266
Mourning Dove - Insectivore						
Tier 1 UTL	N/A	6.69	N/A	0.622	0.002	7.32
Tier 1 UCL	N/A	3.55	N/A	0.330	0.001	3.88
Tier 2 UTL	N/A	2.94	N/A	0.273	0.002	3.21
Tier 2 UCL	N/A	2.15	N/A	0.200	0.001	2.36
American Kestrel						
Tier 1 UTL	N/A	0.535	0.450	0.134	0.002	1.12
Tier 1 UCL	N/A	0.284	0.239	0.071	0.001	0.595
Tier 2 UTL	N/A	0.235	0.197	0.059	0.002	0.493
Tier 2 UCL	N/A	0.172	0.145	0.043	0.001	0.361
Deer Mouse - Insectivore						
Tier 1 UTL	N/A	1.89	N/A	0.038	0.004	1.93
Tier 1 UCL	N/A	1.00	N/A	0.020	0.002	1.03
Tier 2 UTL	N/A	0.830	N/A	0.017	0.004	0.850
Tier 2 UCL	N/A	0.609	N/A	0.012	0.002	0.623

N/A = Not applicable or not available.

272

Table A4.2.25
PMJM Receptor Intake and Exposure Estimates for Tin - Default Exposure Scenario

Bioaccumulation Factors						
Soil to Plant	Soil to Invertebrate	Soil to Small Mammal				
0.03	1	0.21				
Media Concentrations (mg/kg)						
Patch	**Soil Concentration**	**Statistic**	**Plant**	**Earthworm**	**Small Mammal**	**Surface Water (mg/L)**
23	37.2	MDC	1.1	37.2	7.8	0.025
23	11	UTL	0.3	11.0	2.3	0.019
23	3.6	UCL	0.1	3.6	0.8	0.009
23	2.24	Mean	0.1	2.2	0.5	0.006
25	25.5	MDC	0.8	25.5	5.4	0.025
Intake Parameters						
	$IR_{(food)}$ (kg/kg BW/day)	$IR_{(water)}$ (kg/kg BW/day)	$IR_{(soil)}$ (kg/kg BW/day)	P_{plant}	P_{invert}	P_{mammal}
PMJM	0.17	0.15	0.004	0.7	0.3	0
Intake Estimates (mg/kg BW day)						
	Plant Tissue	**Invertebrate Tissue**	**Mammal Tissue**	**Soil**	**Surface Water**	**Total**
Patch 23						
MDC	0.133	1.90	N/A	0.152	0.004	2.19
UTL	0.039	0.561	N/A	0.045	0.003	0.648
UCL	0.013	0.184	N/A	0.015	0.001	0.212
Mean	0.008	0.114	N/A	0.009	9.00E-04	0.132
Patch 25						
MDC	0.091	1.30	N/A	0.104	0.004	1.50

N/A = Not applicable or not available.

Table A4.2.26

Non-PMJM Receptor Hazard Quotients for Surface Soils in the LWOEU - Tin

Receptor/ EPC Statistic	Total Intake (mg/kg BW day)	TRV (mg/kg BW day)		Hazard Quotients	
		NOAEL	LOAEL	NOAEL	LOAEL
Tin (Default Exposure)					
Mourning Dove - Herbivore					
Tier 1 UTL	0.826	0.730	18.3	**1**	0.05
Tier 1 UCL	0.438	0.730	18.3	0.6	0.02
Tier 2 UTL	0.364	0.730	18.3	0.5	0.02
Tier 2 UCL	0.266	0.730	18.3	0.4	0.01
Mourning Dove - Insectivore					
Tier 1 UTL	7.32	0.730	18.3	**10**	0.4
Tier 1 UCL	3.88	0.730	18.3	**5**	0.2
Tier 2 UTL	3.21	0.730	18.3	**4**	0.2
Tier 2 UCL	2.36	0.730	18.3	**3**	0.1
American Kestrel					
Tier 1 UTL	1.12	0.730	18.3	**2**	0.1
Tier 1 UCL	0.595	0.730	18.3	0.8	0.03
Tier 2 UTL	0.493	0.730	18.3	0.7	0.03
Tier 2 UCL	0.361	0.730	18.3	0.5	0.02
Deer Mouse - Insectivore					
Tier 1 UTL	1.93	0.250	15.0	**8**	0.1
Tier 1 UCL	1.03	0.250	15.0	**4**	0.1
Tier 2 UTL	0.850	0.250	15.0	**3**	0.1
Tier 2 UCL	0.623	0.250	15.0	**2**	0.04

Bold = Hazard quotients>1.

273

Table A4.2.27
PMJM Receptor Hazard Quotients for Surface Soils in LWOEU - Tin

Patch/ EPC Statistic	Total Intake (mg/kg BW day)	TRV (mg/kg BW day)		Hazard Quotients	
		NOAEL	LOAEL	NOAEL	LOAEL
Tin (Default Exposure)					
Patch 23					
MDC	2.19E+00	2.50E-01	1.50E+01	**9**	0.1
UTL	6.48E-01	2.50E-01	1.50E+01	**3**	0.04
UCL	2.12E-01	2.50E-01	1.50E+01	0.8	0.01
Mean	1.32E-01	2.50E-01	1.50E+01	0.5	0.01
Patch 25					
MDC	1.50E+00	2.50E-01	1.50E+01	**6**	0.1

Bold = Hazard quotients>1.

274

215

Table A4.2.28
Intake and Exposure Estimates for Vanadium - Default Exposure Scenario

Bioaccumulation Factors						
Soil to Plant	Soil to Invertebrate	Soil to Small Mammal				
0.0097	0.088	0.0131				
Media Concentrations (mg/kg)						
Soil Concentration	**Statistic**	**Plant**	**Earthworm**	**Small Mammal**	**Surface Water (mg/L)**	
58.4	Tier 1 UTL	0.57	5.1	0.77	0.008	
41.8	Tier 1 UCL	0.41	3.7	0.55	0.006	
39.1	Tier 2 UTL	0.38	3.4	0.51	0.008	
35.6	Tier 2 UCL	0.35	3.1	0.47	0.006	
Intake Parameters						
	$IR_{(food)}$ (kg/kg BW day)	$IR_{(water)}$ (kg/kg BW day)	$IR_{(soil)}$ (kg/kg BW day)	P_{plant}	P_{invert}	P_{mammal}
Deer Mouse - Insectivore	0.065	0.19	0.001	0	1	0
Intake Estimates (mg/kg BW day)						
	Plant Tissue	**Invertebrate Tissue**	**Mammal Tissue**	**Soil**	**Surface Water**	**Total**
Deer Mouse - Insectivore						
Tier 1 UTL	N/A	0.334	N/A	0.076	0.002	0.411
Tier 1 UCL	N/A	0.239	N/A	0.054	0.001	0.295
Tier 2 UTL	N/A	0.224	N/A	0.051	0.002	0.276
Tier 2 UCL	N/A	0.204	N/A	0.046	0.001	0.251

N/A = Not applicable or not available.

276

Table A4.2.29

PMJM Receptor Intake and Exposure Estimates for Vanadium - Default Exposure Scenario

Bioaccumulation Factors						
Soil to Plant	Soil to Invertebrate	Soil to Small Mammal				
0.0097	0.088	0.0131				
Media Concentrations (mg/kg)						
Patch	Soil Concentration	Statistic	Plant	Earthworm	Small Mammal	Surface Water (mg/L)
22	49	MDC	0.5	4.3	0.6	0.073
22	46.5	Mean	0.5	4.1	0.6	0.003
23	59	MDC	0.6	5.2	0.8	0.073
23	58.9	UTL	0.6	5.2	0.8	0.008
23	45.5	UCL	0.4	4.0	0.6	0.006
23	43	Mean	0.4	3.8	0.6	0.003
Intake Parameters						
	$IR_{(food)}$ (kg/kg BW day)	$IR_{(water)}$ (kg/kg BW day)	$IR_{(soil)}$ (kg/kg BW day)	P_{plant}	P_{invert}	P_{mammal}
PMJM	0.17	0.15	0.004	0.7	0.3	0
Intake Estimates (mg/kg BW day)						
	Plant Tissue	Invertebrate Tissue	Mammal Tissue	Soil	Surface Water	Total
Patch 22						
MDC	0.057	0.220	N/A	0.200	0.011	0.487
Mean	0.054	0.209	N/A	0.190	4.50E-04	0.453
Patch 23						
MDC	0.068	0.265	N/A	0.241	0.011	0.585
UTL	0.068	0.264	N/A	0.240	0.001	0.574
UCL	0.053	0.204	N/A	0.186	9.00E-04	0.443
Mean	0.050	0.193	N/A	0.175	4.50E-04	0.419

N/A = Not applicable or not available.

Table A4.2.30

Terrestrial Plant Hazard Quotients for Surface Soils in the LWOEU - Vanadium

EPC Statistic	Concentration (mg/kg)	TRV (mg/kg)		Hazard Quotients	
		Screening ESL	Alternate LOEC	Screening ESL	Alternate LOEC
Terrestrial Plant					
Tier 1 UTL	58.4	2.00	50.0	**29**	1
Tier 1 UCL	41.8	2.00	50.0	**21**	0.8
Tier 2 UTL	39.1	2.00	50.0	**20**	0.8
Tier 2 UCL	35.6	2.00	50.0	**18**	0.7

Bold = Hazard quotients>1.

Table A4.2.31
Non-PMJM Receptor Hazard Quotients for Surface Soils in the LWOEU - Vanadium

Receptor/EPC Statistic	Total Intake (mg/kg BW day)	TRV (mg/kg BW day)		Hazard Quotients	
		NOAEL	LOAEL	NOAEL	LOAEL
Vanadium (Default Exposure)					
Deer Mouse - Insectivore					
Tier 1 UTL	0.411	0.210	2.10	**2**	0.2
Tier 1 UCL	0.295	0.210	2.10	1	0.1
Tier 2 UTL	0.276	0.210	2.10	1	0.1
Tier 2 UCL	0.251	0.210	2.10	1	0.1

Bold = Hazard quotients>1.

Table A4.2.32

PMJM Receptor Hazard Quotients for Surface Soils in LWOEU - Vanadium

Patch/ EPC Statistic	Total Intake (mg/kg BW day)	TRV (mg/kg)		Hazard Quotients	
		NOAEL	LOAEL	NOAEL	LOAEL
Vanadium (Default Exposure)					
Patch 22					
MDC	4.87E-01	2.10E-01	2.10E+00	**2**	0.2
Mean	4.53E-01	2.10E-01	2.10E+00	**2**	0.2
Patch 23					
MDC	5.85E-01	2.10E-01	2.10E+00	**3**	0.3
UTL	5.74E-01	2.10E-01	2.10E+00	**3**	0.3
UCL	4.43E-01	2.10E-01	2.10E+00	**2**	0.2
Mean	0.419	0.210	2.10	**2**	0.2

Bold = Hazard quotients>1.

279

280

Table A4.2.33
PMJM Receptor Intake and Exposure Estimates for Selenium - Default Exposure Scenario

Bioaccumulation Factors						
Soil to Plant	Soil to Invertebrate	Soil to Small Mammal				
$\ln C_p = -0.678 + 1.104 (\ln C_s)$	$\ln C_i = -0.075 + 0.733 (\ln C_s)$	$\ln C_{sm} = -0.4158 + 0.3764 (\ln C_s)$				
Media Concentrations (mg/kg)						
Patch	**Soil Concentration**	**Statistic**	**Plant**	**Earthworm**	**Small Mammal**	**Surface Water (mg/L)**
23	2	MDC	1.09	1.54	0.86	0.038
23	1	UTL	0.51	0.93	0.66	0.003
23	0.6	UCL	0.29	0.64	0.54	0.004
23	0.522	Mean	0.25	0.58	0.52	0.002
Intake Parameters						
	$IR_{(food)}$ (kg/kg BW day)	$IR_{(water)}$ (kg/kg BW day)	$IR_{(soil)}$ (kg/kg BW day)	P_{plant}	P_{invert}	P_{mammal}
PMJM	0.17	0.15	0.004	0.7	0.3	0
Intake Estimates (mg/kg BW day)						
	Plant Tissue	**Invertebrate Tissue**	**Mammal Tissue**	**Soil**	**Surface Water**	**Total**
Patch 23						
MDC	0.130	0.079	N/A	0.008	0.006	0.222
UTL	0.060	0.047	N/A	0.004	4.50E-04	0.112
UCL	0.034	0.033	N/A	0.002	6.00E-04	0.070
Mean	0.029	0.029	N/A	0.002	3.00E-04	0.061

N/A = Not applicable or not available.

Table A4.2.34
PMJM Receptor Hazard Quotients for Surface Soils in LWOEU - Selenium

Patch/ EPC Statistic	Total Intake (mg/kg BW day)	TRV (mg/kg BW day)		Hazard Quotients	
		NOAEL	LOAEL	NOAEL	LOAEL
Selenium (Default Exposure)					
Patch 23					
MDC	0.222	0.050	1.21	**4**	0.2
UTL	0.112	0.050	1.21	**2**	0.1
UCL	0.070	0.050	1.21	1	0.1
Mean	0.061	0.050	1.21	1	0.1

Bold = Hazard quotients>1.

282

Table A4.2.35

PMJM Receptor Intake and Exposure Estimates for Zinc - Default Exposure Scenario

Bioaccumulation Factors						
Soil to Plant	Soil to Invertebrate	Soil to Small Mammal				
lnCp = 1.575 + 0.554 (ln Cs)	lnCi = 4.449 + 0.328 (ln Cs)	lnCsm = 4.4987 + 0.0745 (ln Cs)				
Media Concentrations (mg/kg)						
Patch	Soil Concentration	Statistic	Plant	Earthworm	Small Mammal	Surface Water (mg/L)
23.0	84	MDC	56.24	365.88	125.06	0.27
23	79.8	UTL	54.67	359.78	124.58	0.33
23	61.4	UCL	47.28	330.14	122.17	0.015
23	58	Mean	45.81	324.03	121.66	0.013
27	86.1	MDC	57.02	368.86	125.29	0.27
27	66.2	Mean	49.29	338.39	122.86	0.013
Intake Parameters						
	$IR_{(food)}$ (kg/kg BW/day)	$IR_{(water)}$ (kg/kg BW/day)	$IR_{(soil)}$ (kg/kg BW/day)	P_{plant}	P_{invert}	P_{mammal}
PMJM	0.17	0.15	0.004	0.7	0.3	0
Intake Estimates (mg/kg BW day)						
	Plant Tissue	Invertebrate Tissue	Mammal Tissue	Soil	Surface Water	Total
Patch 23						
MDC	6.69	18.7	N/A	0.343	0.041	25.7
UTL	6.51	18.3	N/A	0.326	0.050	25.2
UCL	5.63	16.8	N/A	0.251	0.002	22.7
Mean	5.45	16.5	N/A	0.237	0.002	22.2
Patch 27						
MDC	6.79	18.8	N/A	0.351	0.041	26.0
Mean	5.87	17.3	N/A	0.270	0.002	23.4

N/A = Not applicable or not available.

Table A4.2.36
PMJM Receptor Hazard Quotients for Surface Soils in LWOEU - Zinc

Patch/ EPC Statistic	Total Intake (mg/kg BW day)	TRV (mg/kg BW day)		Hazard Quotients	
		NOAEL	LOAEL	NOAEL	LOAEL
Zinc (Default Exposure)					
Patch 23					
MDC	25.7	9.61	411	**3**	0.1
UTL	25.2	9.61	411	**3**	0.1
UCL	22.7	9.61	411	**2**	0.1
Mean	22.2	9.61	411	**2**	0.1
Patch 27					
MDC	26.0	9.61	411	**3**	0.1
Mean	23.4	9.61	411	**2**	0.1

Bold = Hazard quotients>1.

283

COMPREHENSIVE RISK ASSESSMENT

LOWER WOMAN DRAINAGE EXPOSURE UNIT

VOLUME 11: ATTACHMENT 5

Chemical-Specific Uncertainty Analysis

TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS iii
1.0 INTRODUCTION 1
1.1 Chromium 1
1.2 Copper 4
1.3 Manganese 5
1.4 Nickel 6
1.5 Selenium 8
1.6 Thallium 9
1.7 Tin 9
1.8 Vanadium 10
1.9 Zinc 12
2.0 REFERENCES 13

285

ACRONYMS AND ABBREVIATIONS

BFA	Bioaccumulation Factors
BW	body weight
CRA	Comprehensive Risk Assessment
ECOPC	ecological contaminant of potential concern
EcoSSL	Ecological Soil Screening Level
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
ESL	ecological screening level
HQ	hazard quotient
LOAEL	lowest observed adverse effect level
LOEC	lowest observed effect concentration
mg/kg	milligrams per kilogram
mg/kg/BW/day	milligram per kilogram per receptor body weight per day
NOAEL	no observed adverse effect level
NOEC	no observed effect concentration
PMJM	Preble's meadow jumping mouse
PRC	PRC Environmental Management, Inc
RFETS	Rocky Flats Environmental Technology Site
TRV	toxicity reference value
UCL	upper confidence limit
UTL	upper tolerance limit

1.0 INTRODUCTION

One potential limitation of the hazard quotient (HQ) approach is that calculated HQ values may sometimes be uncertain due to simplifications and assumptions in the underlying exposure and toxicity data used to derive the HQs. Where possible, this risk assessment provides information on two potential sources of uncertainty, described below.

- **Bioaccumulation Factors (BAFs).** For wildlife receptors, concentrations of contaminants in dietary items were estimated from surface soil using uptake equations. When the uptake equation was based on a simple linear model (e.g., $C_{tissue} = BAF * C_{soil}$), the default exposure scenario used a high-end estimate of the BAF (the 90th percentile BAF). However, the use of high-end BAFs may tend to overestimate tissue concentrations in some dietary items. If necessary, to estimate more typical tissue concentrations, an alternative exposure scenario calculated total chemical intake using a 50th percentile (median) BAF. The use of the median BAF is consistent with the approach used in the ecological soil screening level (EcoSSL) guidance (EPA 2005).
- **Toxicity Reference Values (TRVs).** The Final Comprehensive Risk Assessment (CRA) Work Plan and Methodology (DOE 2004), hereafter referred to as the CRA Methodology, used an established hierarchy to identify the most appropriate default TRVs for use in the ecological contaminant of potential concern (ECOPC) selection. However, in some instances, the default TRV selected may be overly conservative with regard to characterizing population-level risks. The determination of whether the default TRVs are thought to yield overly conservative estimates of risk is addressed in the uncertainty sections below on a chemical-by-chemical basis. If lowest observed adverse effect level (LOAEL) HQs greater than 1 were calculated using the default HQ calculations and an alternative TRV is identified, the chemical-specific uncertainty sections provide a discussion of why the alternative TRV is thought to be appropriate to provide an alternative estimate of toxicity (e.g., endpoint relevance, species relevance, data quality, chemical form, etc.).

The influences of each of these uncertainties on the calculated HQs are discussed for each ECOPC in the following subsections.

1.1 Chromium

Bioaccumulation Factors

There are several important uncertainties associated with the intake and HQ calculations for vertebrate receptors. Chromium has two types of bioaccumulation factors used in the intake calculations. For the soil-to-small mammal BAF, a regression equation was used to estimate tissue concentrations. Confidence placed in this value is high; however, uncertainty is unavoidable when using even high-quality models to predict tissue concentrations. In cases without available measurements of tissue concentrations, regression-based models are generally the best available predictor of tissue

286

concentrations. However, the regression-based BAFs may still overestimate or underestimate tissue concentrations of chromium to an unknown degree.

The soil-to-invertebrate and soil-to-plant BAFs used to estimate invertebrate tissue concentrations are both based on screening-level upper-bound (90th percentile) BAFs presented in Sample et al. (1998a) and ORNL (1998). These values provide conservative estimates of uptake from soils to invertebrate and plant tissues. This conservative estimate may serve to overestimate chromium concentrations in tissues. For this reason, the median BAFs presented in the same documents were used as alternative BAFs to estimate invertebrate and plant tissue concentrations as recommended in U.S. Environmental Protection Agency (EPA) EcoSSL guidance (EPA 2005). It is unclear whether the use of median BAFs reduces the uncertainty involved in the estimation of invertebrate tissue concentrations, but the likelihood of overestimation of risks is reduced.

Toxicity Reference Values

For terrestrial plants, the summary of chromium toxicity in Efroymson et al. (1997a) places low confidence in the value because there are no primary reference data showing toxicity to plants and the basis for the no observed effect concentration (NOEC) ecological screening level (ESL) is not discussed in the document. The document simply notes that confidence in the values is low due to the small number of studies on which it was based. Efroymson et al. (1997a) also provides plant toxicity values from Turner and Rust (1971) that are based on growth effects on plants grown in loamy soils. No effects to plant growth were noted at 10 milligram per kilogram (mg/kg), while shoot weight was reduced by 30 percent at chromium concentrations equal to 30 mg/kg. Uncertainty is high using the alternative values but reduced from the unspecified and unsupported 1 mg/kg value used as the ESL.

For terrestrial invertebrates, the ESL is based on survival effects to earthworms exposed to hexavalent chromium (chromium VI). Severe effects on survival were noted at 2 mg/kg chromium VI. The 0.4 mg/kg ESL was calculated by Efroymson et al. (1997b) by dividing by a safety factor of 5. There is some uncertainty in the chromium VI TRV because trivalent chromium (chromium III) is the most prevalent form of inorganic chromium found in soils (Kabata-Pendias 2002) and chromium VI was rarely detected when sampled for anywhere at Rocky Flats Environmental Technology Site (RFETs). This introduces uncertainty into the TRV selection process as chromium VI is regarded as the more toxic form of chromium. Efroymson et al. (1997b) also provide data for a lowest observed effect concentration (LOEC) where growth to earthworms was reduced by 30 percent at 32.6 mg/kg of chromium III. The alternative chromium III LOEC provides a useful alternative estimate of toxicity based on a more applicable estimate of chromium III toxicity.

The no observed adverse effect level (NOAEL) and LOAEL TRVs for birds were obtained from Sample et al. (1996). The mammalian TRV was based on effects from chromium VI, while the bird TRV was based on effects from chromium III.

The NOAEL TRV for chromium VI represents a dose of at which no effects to the survival of ducks were noted. The LOAEL TRV represents a dose rate at which a decrease in survivability was noted in the same study. No threshold TRV was calculated in the CRA Methodology, and one is not identified here. Therefore, the threshold for chromium VI toxicity lies somewhere between the NOAEL and LOAEL, but the actual intake rate is uncertain.

There is some uncertainty in the chromium VI TRV because chromium III is the most prevalent form of inorganic chromium found in soils (Kabata-Pendias 2002), and chromium VI was rarely detected when sampled for anywhere at RFETS. This introduces uncertainty into the TRV selection process as chromium VI is regarded as the more toxic form of chromium (IRIS 2005). The bird TRVs are based on mortality effects in black ducks and are based on chromium II toxicity. These values are based on appropriate endpoints, and uncertainty in them is considered low. No alternative TRVs were identified for chromium III and none were available for chromium VI.

NOAEL and LOAEL TRVs for chromium VI were available for estimating risk to mammals. Only a NOAEL TRV was available for assessing risks to mammals from exposure to chromium III. All of the mammalian TRVs were obtained from Sample et al. (1996) and relate to reproduction and mortaility endpoints. Both the chromium VI and chromium III TRVs were used in the default analysis. As discussed above for birds, the use of the chromium VI TRV is likely to overestimate risks. The chromium VI NOAEL is less than the chromium III NOAEL by three orders of magnitude for similar endpoints. Care should be taken when reviewing the HQs calculated using the chromium VI TRVs. Uncertainty is also introduced into the risk estimates due to the lack of a LOAEL TRV for chromium. Because both TRVs were based on acceptable endpoints, no alternative TRVs were identified.

Background Risks

Chromium was detected in RFETS background surface soils. Because risks are generally not expected at naturally occurring background levels, it is important to calculate the risks that would be predicted at naturally occurring concentrations using the same assumptions and models as used in the CRA. This provides information necessary to gauge the predictive ability of the risk assessment models used in the CRA. In addition, risks calculated using background data can provide additional information on the magnitude of potentially site-related risks.

Risks to the terrestrial plants, terrestrial invertebrates, mourning dove (herbivore and insectivore), American kestrel, deer mouse (insectivore), and Preble's meadow jumping mouse (PMJM) were calculated using both the upper confidence limit (UCL) and upper tolerance limit (UTL) of background soils. NOAEL HQs greater than 1 were calculated for terrestrial plants, terrestrial invertebrates, and mourning dove (insectivore), with both the UCL, and UTL exposure point concentrations (EPCs). NOAEL HQs for terrestrial plants equaled 17 using the UTL, while those calculated for terrestrial invertebrates equaled 42. Both NOAEL and LOAEL HQs greater than 1 were calculated for the mourning dove (insectivore). The LOAEL HQ equaled 3 using the UTL EPC, indicating potentially significant risks at background concentrations. No LOAEL TRVs were available for terrestrial plants or invertebrates. Attachment 3 indicated that background concentrations are within the range of concentrations that would be expected. The mean

287

concentration of chromium in soils of Colorado and the bordering states was 48.2 mg/kg versus 16.9 mg/kg in site-specific background samples. Because risks are not typically expected at normal background concentrations, this conservatism should be accounted for in risk management decisions.

1.2 Copper

Bioaccumulation Factors

For the soil-to-plant, soil-to-invertebrate, and soil-to-small mammal BAFs, regression equations were used to estimate plant tissue concentrations. Confidence placed in these values is high; however, uncertainty is unavoidable when using even high-quality models to predict tissue concentrations. In cases without available measurements of tissue concentrations, regression-based models are generally the best available predictor of tissue concentrations. However, the regression-based BAFs may still overestimate or underestimate tissue concentrations of copper to an unknown degree.

Toxicity Reference Values

The NOAEL and LOAEL TRVs for birds were obtained from PRC Environmental Management, Inc. (PRC) (PRC 1994). The PRC document reviewed the available effects database for avian effects from copper. The NOAEL TRV represents a dose of copper at which no growth, developmental, reproductive, or mortality effects were noted. The LOAEL TRV represents a dose rate at which an increase in the erosion of chicken gizzards was noted. The CRA Methodology noted that the nature of the effect predicted by the LOAEL TRV is not likely to cause significant effects on growth, reproduction, or survival in birds and, subsequently, calculated a threshold TRV. The threshold TRV represents an estimate of the point between the NOAEL and LOAEL TRVs where effects related to the LOAEL TRV may begin to occur. This point is uncertain and it is impossible to accurately estimate where the threshold for effects lies given the available data. Therefore, the calculation of the threshold TRV may overestimate or underestimate the calculated risks by a degree less than half of the difference between the NOAEL and LOAEL TRVs. In addition, the ability of the LOAEL TRV endpoint to predict effects to populations of avian receptors at RFETS under the assessment endpoints used in this CRA is uncertain. The effect that gizzard erosion in birds has on population-level endpoints is unclear, but risk estimations are likely to be conservative and over-predict risk. However, Sample et al. (1996), a CRA Methodology-approved TRV source, provides avian TRVs for growth and mortality endpoints to neonate chickens that are very similar to the LOAEL TRV from PRC (PRC LOAEL = 52.3 mg/kg/receptor body weight [BW]/day; Sample LOAEL = 61.7 mg/kg/BW/day). Because the two LOAEL values are similar, the uncertainty in the PRC LOAEL is reduced and no alternative TRVs are provided to calculate risk to the mourning dove receptors. The PRC value is considered to be protective of growth and mortality effects in birds. Although it may over-predict risks, the degree is likely to be small.

Background Risks

Copper was detected in RFETS background surface soils. Because risks are generally not expected at naturally occurring background levels, it is important to calculate the risks that would be predicted at naturally occurring concentrations using the same assumptions and models as used in the CRA. This provides information necessary to gauge the predictive ability of the risk assessment models used in the CRA. In addition, risks calculated using background data can provide additional information on the magnitude of potentially site-related risks.

Risks to the mourning dove (herbivore and insectivore) were calculated using both the UCL and UTL of background soils. No HQs greater than 1 were calculated for either receptor using the NOAEL, threshold, or LOAEL TRVs. NOAEL HQs equal to 1 were calculated for the mourning dove (insectivore) with both the UCL and UTL EPCs. NOAEL HQs for the mourning dove (herbivore) equaled 0.7 for the UCL and UTL EPCs.

1.3 Manganese

Bioaccumulation Factors

There are several important uncertainties associated with the intake and HQ calculations for vertebrate receptors. Manganese has two types of bioaccumulation factors used in the intake calculations. For the soil-to-invertebrate BAF, a regression equation was used to estimate tissue concentrations. Confidence placed in this value is high; however, uncertainty is unavoidable when using even high-quality models to predict tissue concentrations. In cases without available measurements of tissue concentrations, regression-based models are generally the best available predictor of tissue concentrations. However, the regression-based BAFs may still overestimate or underestimate invertebrate tissue concentrations of manganese to an unknown degree.

The soil-to-plant and soil-to-small mammal BAFs used to estimate tissue concentrations are based on screening-level upper bound (90th percentile) BAFs presented in ORNL (1998) and Sample et al. (1998b). These values provide conservative estimates of uptake from soils to tissues. This conservative estimate may serve to overestimate manganese concentrations in plant and small mammal tissues. For this reason, the median BAFs presented in the same document were used as alternative BAFs to estimate tissue concentrations. It is unclear whether the use of median BAFs reduces the uncertainty involved in the estimation of plant and small mammal tissue concentrations, but the likelihood of overestimation of risks is reduced. In addition, the conservative nature of the upper-bound soil-to-plant BAF directly affects the conservatisms in the soil-to-small mammal BAF that uses both the soil-to-plant and soil-to-invertebrate BAFs in its calculation. It is unclear to what degree and direction that uncertainty can be estimated for the soil-to-small mammal BAF, but the uncertainty associated with the estimated small mammal tissue concentrations is high.

Toxicity Reference Values

The NOAEL and LOAEL TRVs for mammalian receptors were obtained from PRC (1994), a CRA Methodology-approved source of TRVs. The LOAEL TRV represents an intake rate at which a decrease in testical weight in mice was noted. The NOAEL TRV was taken from the same study and represents an intake rate at which no effects on testicular weight was noted. No threshold TRV was identified in the CRA Methodology,

288

thus it is unknown where the threshold for effects lies at intake rates lower than the LOAEL TRV. In addition, no relationship appears to have been identified between decreased testicular weight to reductions in reproductive success. This introduces some uncertainty into the risk assessment. However, because the endpoint for the LOAEL TRV is based on potential reproductive effects, the uncertainty is likely to be limited. Risks predicted by the LOAEL TRV may be overestimated, but the degree of uncertainty is low.

Background Risks

Manganese was detected in RFETS background surface soils. Because risks are generally not expected at naturally occurring background levels, it is important to calculate the risks that would be predicted at naturally occurring concentrations using the same assumptions and models as used in the CRA. This provides information necessary to gauge the predictive ability of the risk assessment models used in the CRA. In addition, risks calculated using background data can provide additional information on the magnitude of potentially site-related risks.

Risks to all receptors were calculated using both the UCL and UTL of background soils. NOAEL HQs greater than 1 were calculated for the mourning dove (herbivore and insectivore). NOAEL HQs equaled 5 and 4 respectively when calculated using the background UTL as the EPC. No HQs greater than 1 were calculated for any receptor using LOAEL TRVs.

1.4 Nickel

Bioaccumulation Factors

There are several important uncertainties associated with the intake and HQ calculations for vertebrate receptors. Nickel has two types of bioaccumulation factors used in the intake calculations. For the soil-to-plant and soil-to-small mammal BAFs, regression equations were used to estimate tissue concentrations. Confidence placed in these values is high; however, uncertainty is unavoidable when using even high-quality models to predict tissue concentrations. In cases without available measurements of tissue concentrations, regression-based models are generally the best available predictor of tissue concentrations. However, the regression-based BAFs may still overestimate or underestimate tissue concentrations of nickel to an unknown degree.

The soil-to-invertebrate BAF used to estimate invertebrate tissue concentrations is based on a screening-level upper bound (90th percentile) BAF presented in Sample et al. (1998a). This value provides a conservative estimate of uptake from soils to invertebrate tissues. This conservative estimate may serve to overestimate nickel concentrations in invertebrate tissues. For this reason, the median BAF presented in the same document (Sample et al. 1998b) can be used as an alternative BAF to estimate invertebrate tissue concentrations.

It is unclear whether the use of median BAFs reduces the uncertainty involved in the estimation of invertebrate tissue concentrations, but the likelihood of overestimation of risks is reduced.

Toxicity Reference Values

Uncertainty is also present in the TRVs used in the default HQ calculations for nickel. The NOAEL-based ESL calculated for the deer mouse (insectivore) was equal to 0.431 mg/kg, a concentration less than all site-specific background samples (minimum background concentration = 3.8 mg/kg). The NOAEL TRV used to calculate the ESL was estimated from the LOAEL TRV in the CRA Methodology by dividing by a factor of 10. The LOAEL TRV for mammals (1.33 mg/kg/BW/day) is based on pup mortality in rats. Given that the LOAEL TRV is 10 times the NOAEL TRV, a back-calculated soil concentration using the LOAEL TRV equals 3.8 mg/kg. This concentration is equal to the minimum detected concentration of nickel in background soils and would be exceeded by 19 of the 20 site-specific background soil concentrations. Because risks to ecological receptors are not generally expected in background areas, this indicates that the default TRVs used to calculate risks for mammals in general, and the deer mouse (insectivore) specifically, are too conservative and risks are over-predicted when using these TRVs.

For avian receptors, there is also uncertainty in the quality of the TRVs selected in the CRA Methodology to predict population-level effects to birds at RFETS. The TRVs selected by PRC (1994) relate to the prediction of edema and swelling in leg and foot joints in mallard ducks. The CRA Methodology noted that the nature of the effect predicted by the LOAEL TRV is not likely to cause significant effects on growth, reproduction, or survival in birds and, subsequently, calculated a threshold TRV. The threshold TRV represents an estimate of the point between the NOAEL and LOAEL TRVs where effects related to the LOAEL TRV may begin to occur. This point is uncertain, and it is impossible to accurately estimate where the threshold for effects lies. Therefore, the calculation of the threshold TRV may overestimate or underestimate the calculated risks by a degree less than half of the difference between the NOAEL and LOAEL TRVs. In addition, the ability of the LOAEL TRV endpoint to predict effects to populations of avian receptors at RFETS under the assessment endpoints used in this CRA is also uncertain. The effect that swelling of leg and toe joints in birds has on population-level endpoints is unclear and risk estimations are likely to be conservative and over-predict risks related to the assessment endpoints.

The CRA Methodology prescribed a hierarchy of TRV sources from which TRVs could be identified and used without modification. TRVs were selected first from EPA EcoSSL guidance (EPA 2003) from which no nickel TRVs were available. The second Tier TRV source was PRC (1994), from which the LOAEL TRV was obtained and the NOAEL TRV was estimated. Because these values appear to be highly-conservative, the third Tier TRV source (Sample et al. 1996) was reviewed for a usable TRV. Sample et al. (1996) presents TRVs for birds and mammals.

The use of these alternative risk calculations serves to provide an estimate of risk using a reasonable, yet reduced, level of conservatism for all receptors and a reduction of uncertainty (to an unknown extent) for the mourning dove (insectivore) receptor.

289

Background Risks

Nickel was detected in RFETS background surface soils. Because risks are generally not expected at naturally occurring background levels, it is important to calculate the risks that would be predicted at naturally occurring concentrations using the same assumptions and models as used in the CRA. This provides information necessary to gauge the predictive ability of the risk assessment models used in the CRA. In addition, risks calculated using background data can provide additional information on the magnitude of potentially site-related risks.

Risks to the PMJM, deer mouse (insectivore and herbivore), coyote (generalist and insectivore), and mourning dove (insectivore) were calculated using both the UCL and UTL of background soils and default NOAEL, threshold (mourning dove only), and LOAEL TRVs.

NOAEL HQs greater or equal to 1 for all receptors were calculated using both the UCL and UTL background surface soil concentrations. NOAEL HQs ranged from 1 for the deer mouse (herbivore) to 27 for the PMJM. LOAEL HQs were less than 1 for the deer mouse (herbivore), mourning dove (insectivore), and both coyote receptors but greater than 1 for the PMJM (HQ = 3) and deer mouse (insectivore) (HQ = 3). Attachment 3 indicated that background concentrations are within the range of concentrations that would be expected in Colorado and the bordering states. The mean regional background concentration for nickel is 18.8 mg/kg versus 9.6 mg/kg in site-specific background. Because risks are not typically expected at normal background concentrations, this conservatism should be accounted for in risk management decisions.

1.5 Selenium

Bioaccumulation Factors

For the soil-to-invertebrate BAF, a regression equation was used to estimate tissue concentrations. Confidence placed in this value is high; however, uncertainty is unavoidable when using even high-quality models to predict tissue concentrations. In cases without available measurements of tissue concentrations, regression-based models are generally the best available predictor of tissue concentrations. However, the regression-based BAFs may still overestimate or underestimate tissue concentrations of selenium to an unknown degree.

Toxicity Reference Values

The NOAEL and LOAEL TRVs for birds were obtained from PRC Environmental Management, Inc. (PRC 1994). The PRC document reviewed the available effects database mammalian effects of selenium. The NOAEL TRV represents a dose of selenium at which no liver lesions were noted in mice. The LOAEL TRV represents a dose rate at which an increase in the reductions in reproductive success in mice were noted. There is no threshold TRV provided and it is uncertain and impossible to accurately estimate where the threshold for effects lies given the available data. The NOAEL TRV is based on an endpoint with questionable ability to predict risks to populations of mammals. However, the LOAEL TRV is based on an appropriate endpoint for use in the ERA. For this reason, no alternative TRVs are recommended for selenium but HQ results based on the NOAEL TRV should consider the endpoint used for the TRV.

Background Risks

Manganese was detected in RFETS background surface soils. Because risks are generally not expected at naturally occurring background levels, it is important to calculate the risks that would be predicted at naturally occurring concentrations using the same assumptions and models as used in the CRA. This provides information necessary to gauge the predictive ability of the risk assessment models used in the CRA. In addition, risks calculated using background data can provide additional information on the magnitude of potentially site-related risks.

Risks to the mourning dove (herbivore and insectivore) were calculated using both the UCL and UTL of background soils. HQs greater than 1 were calculated for both receptors using the NOAEL TRV. NOAEL HQs equal to 5 were calculated for the mourning dove (insectivore) and 4 for the mourning dove (herbivore) with UTL EPC. No HQs greater than 1 were calculated for either receptor using the LOAEL TRV.

1.6 Thallium

Plant Toxicity

The summary of thallium toxicity in Efroymson et al. (1997a) places low confidence in the value because the NOAEL ESL value is based on unspecified toxic effects. The only alternative TRV that could be located was the same as the default value. The uncertainty associated with the lack of toxicity data for terrestrial plants is high. It is unclear whether risks are overestimated or underestimated by using the default toxicity values, but overestimation is the more likely scenario because the ESL is termed a screening level and represents unclear effects.

Background Risks

Thallium was not detected in background surface soils. Therefore, background risks were not calculated for thallium in Appendix A, Volume 2, Attachment 9 of the Resource Conservation and Recovery Act (RCRA) Facility Investigation-Remedial Investigation/Corrective Measures Study (CMS)-Feasibility Study (RI/FS) Report (hereafter referred to as the RI/FS Report).

1.7 Tin

Bioaccumulation Factors

The primary source of uncertainty in the risk estimation for tin is in the estimation of tissue concentrations. No high-quality regression models or BAF data were available for any of the three soil-to-tissue pathways. As a result, plant tissue concentrations are estimated using a biotransfer factor from soil-to-plant tissue from Baes et al. (1984). The values presented in Baes et al. (1994) were the lowest tier for data quality in the CRA

290

Methodology and represent the most uncertain BAF available. It is unclear whether the Baes et al. (1984) BAFs overestimate or underestimate uptake into plant tissues, and the magnitude of uncertainty is also unknown but could be high.

No data were available to estimate invertebrate concentrations from soil. As a result, a default value of 1 was used. This value assumes that the concentration in invertebrate tissues is equal to the surface soil concentration. There is a large degree of uncertainty in this assumption. Because tin is not expected to bioaccumulate in the food chain, invertebrate tissue concentrations are likely to be overestimated to an unknown degree using this BAF. The lack of quality soil-to-plant and soil-to-invertebrate BAFs directly affects the quality of the soil-to-small mammal BAF that uses the previous two values in its calculation. Compounding the uncertainty for this BAF is a food-to-tissue BAF, again from Baes et al. (1984). It is unclear to what degree and direction that uncertainty can be estimated for the soil-to-small mammal BAF, but the uncertainty associated with the estimated small mammal tissue concentrations is high.

Toxicity Reference Values

The NOAEL and LOAEL TRVs for mammalian receptors were obtained from PRC (1994). The selected NOAEL TRV is protective of systemic effects in mice. These effects are not associated with the assessment endpoints for mammalian receptors at RFETS and, therefore, are overly conservative for use in the CRA. However, the LOAEL TRV selected by PRC (1994) is from a proper endpoint for use in the CRA and is described by PRC (1994) as predictive of a mid-range of effects less than mortality. Therefore, while the uncertainty related to the NOAEL TRV for mammals is high, the uncertainty for the LOAEL TRV is considerably lower. For this reason, no alternative TRVs are recommended in the uncertainty analysis.

For avian receptors, the TRVs selected for use in the CRA were also obtained from PRC (1994) and represent a paired NOAEL and LOAEL from a study on Japanese quail reproduction. No effects on reproduction were noted at the NOAEL, while reduced reproduction was noted at the LOAEL intake rate. Because the endpoints represented by the TRVs are appropriate for use in the CRA, the uncertainty in the avian TRVs for tin is considered to be low.

Background Risks

Tin was not detected in background surface soils, therefore, background risks were not calculated for tin in Appendix A, Volume 2, Attachment 9 of the RI/FS Report.

1.8 Vanadium

Plant Toxicity

The summary of vanadium toxicity in Efroymson et al. (1997a) places low confidence in the value because there are no primary reference data showing toxicity to plants, and the NOAEL ESL value is based on unspecified toxic effects. An alternative LOEC TRV was also available as cited in Efroymson et al. (1997a) and was based again on unspecified effects of vanadium added to soil at a concentration of 50 mg/kg. No information regarding the baseline concentration of vanadium in the soil was available. Low confidence is also placed in the alternative values. The uncertainty associated with the lack of toxicity data for terrestrial plants is high. It is unclear whether risks are overestimated or underestimated by using the default or alternative toxicity values, but overestimation at the screening ESL is the more likely scenario. The alternative LOEC may reduce that uncertainty to an unknown degree.

Bioaccumulation Factors

The soil-to-invertebrate and soil-to-plant BAFs used to estimate invertebrate tissue concentrations are both based on screening-level upper-bound (90th percentile) BAFs presented in Sample et al. (1998a) and ORNL (1998). These values provide conservative estimates of uptake from soils to invertebrate and plant tissues. This conservative estimate may serve to overestimate vanadium concentrations in tissues. For this reason, the median BAFs presented in the same documents were used as alternative BAFs to estimate invertebrate and plant tissue concentrations. It is unclear whether the use of median BAFs reduces the uncertainty involved in the estimation of invertebrate tissue concentrations, but the likelihood of overestimation of risks is reduced.

Toxicity Reference Values

The NOAEL and LOAEL TRVs for mammalian receptors were obtained from Sample et al. (1996), a CRA Methodology-approved source of TRVs. The LOAEL TRV represents an intake rate at which a decrease in reproductive success in mice was noted. No NOAEL TRV was available, thus the NOAEL TRV was estimated from the LOAEL TRV by dividing by a factor of 10. The estimation of the NOAEL TRV from the LOAEL TRV introduces uncertainty into the risk characterization process. It is unknown where the threshold for effects lies at intake rates lower than the LOAEL TRV; therefore, it is also unclear at which intake-rate the true NOAEL lies. However, this source of uncertainty is limited because the LOAEL TRV is of sufficient quality to assess risks and the LOAEL TRV endpoint may be predictive of population risks. Risks predicted by the LOAEL TRV may be overestimated or underestimated, but the degree of uncertainty is low.

Background Risks

Vanadium was detected in RFETS background surface soils. Because risks are generally not expected at naturally occurring background levels, it is important to calculate the risks that would be predicted at naturally occurring concentrations using the same assumptions and models as used in the CRA. This provides information necessary to gauge the predictive ability of the risk assessment models used in the CRA. In addition, risks calculated using background data can provide additional information on the magnitude of potentially site-related risks.

Risks to the terrestrial plant, PMJM, and deer mouse (insectivore and herbivore) were calculated using both the UCL and UTL of background soils and default NOAEL and LOAEL TRVs.

HQs equal to 23 and 15 were calculated for the terrestrial plant receptor using UTL and UCL EPCs, respectively. Because no exposure modeling is conducted for terrestrial plants, this indicates that the ESL may be over-conservative when assessing risks to plant

291

populations. This conservatism should be considered when viewing the results of the risk characterization for vanadium.

NOAEL HQs greater or equal to 1 were calculated using both the UCL and UTL background surface soil concentrations for the PMJM and deer mouse (insectivore) receptors. NOAEL HQs ranged from 1 for both receptors using the UCL to 2 for both receptors using the UTL EPCs. LOAEL HQs were less than 1 for all three receptors.

1.9 Zinc

Bioaccumulation Factors

For the soil-to-plant, soil-to-invertebrate, and soil-to-small mammal BAFs, regression equations were used to estimate plant tissue concentrations. Confidence placed in these values is high. Uncertainty is unavoidable when using even high-quality models to predict tissue concentrations. However, in cases without available measurements of tissue concentrations, regression-based models are the best available predictor of tissue concentrations. The regression-based BAFs may overestimate or underestimate tissue concentrations of zinc to an unknown degree.

Toxicity Reference Values

The NOAEL and LOAEL TRVs for mammalian receptors were obtained from PRC (1994), a CRA Methodology-approved source of TRVs. The LOAEL TRV represents an intake rate at which there is an increased incidence of fetal developmental effects in rats. No NOAEL TRV was available, therefore, the NOAEL TRV was estimated from the LOAEL TRV by dividing by a factor of 10. The estimation of the NOAEL TRV from the LOAEL TRV introduces uncertainty into the risk characterization process. It is unknown where the threshold for effects lies at intake rates lower than the LOAEL TRV; therefore, it is unclear at which intake rate the true NOAEL lies. However, this source of uncertainty is limited because the LOAEL TRV is of sufficient quality to assess risks, and the LOAEL TRV endpoint may be predictive of population risks. Risks predicted by the LOAEL TRV may be overestimated or underestimated but the degree of uncertainty is low.

The NOAEL and LOAEL TRVs for avian receptors were also obtained from PRC (1994). The LOAEL TRV represents an intake rate at which a decrease in body weight of mallard ducks may be predicted. No NOAEL TRV was available, therefore, the NOAEL TRV was estimated from the LOAEL TRV by dividing by a factor of 10. The estimation of the NOAEL TRV from the LOAEL TRV introduces uncertainty into the risk characterization process. It is unknown where the threshold for effects lies at intake rates lower than the LOAEL TRV; therefore, it is unclear at which intake rate the true NOAEL lies. In addition, this source of uncertainty may be compounded because the LOAEL TRV is predictive of effects that are questionable in their ability to predict population-level effects related to the assessment endpoints. Risks predicted by the LOAEL TRV may be overestimated, by an uncertain degree.

Background Risks

Zinc was detected in RFETS background surface soils. Because risks are generally not expected at naturally occurring background levels, it is important to calculate the risks that would be predicted at naturally occurring concentrations using the same assumptions and models as used in the CRA. This provides information necessary to gauge the predictive ability of the risk assessment models used in the CRA. In addition, risks calculated using background data can provide additional information on the magnitude of potentially site-related risks.

Risks to the terrestrial plant, PMJM, deer mouse (insectivore), mourning dove (herbivore and insectivore), and American kestrel were calculated using both the UCL and UTL of background soils and default NOAEL and LOAEL TRVs.

HQs equal to 2 and 1 were calculated for the terrestrial plant receptor using UTL and UCL EPCs, respectively. Because no exposure modeling is conducted for terrestrial plants, this indicates that the ESL is likely to be slightly conservative when assessing risks to plant populations. This conservatism should be considered when viewing the results of the risk characterization for zinc.

NOAEL HQs greater than 1 were calculated using both the UCL and UTL background surface soil concentrations for the PMJM, deer mouse (insectivore), and mourning dove (insectivore) receptors. NOAEL HQs ranged from 2 for deer mouse (insectivore), using both EPCs, to 5 for the mourning dove (insectivore), using the UTL. LOAEL HQs were less than 1 for all receptors.

2.0 REFERENCES

Baes, C.F., R.D. Sharp, A.L. Sjoreen, and R.W. Shor, 1984, A review and analysis of parameters for assessing transport of environmentally released radionuclides through agriculture. Oak Ridge National Laboratory. USDOE> ORNL-5786. September 1984.

EPA, 2003. Guidance for Developing Ecological Soil Screening Levels (Eco-SSLs). OSWER 9285.7-55. Office of Solid Waste and Emergency Response. December.

EPA, 2005. Guidance for Developing Ecological Soil Screening Levels (Eco-SSLs). Attachment 4-1 Update. Office of Solid Waste and Emergency Response, February.

Efroymson, R.A., M.E. Will, G.W. Suter II, and A.C. Wooten, 1997a. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants. 1997 Revision, ES/ER/TM-85/R3. Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Efroymson, R.A., M.E. Will, and G.W. Suter, 1997b. Toxicological benchmarks for contaminants of potential concern for effects on soil and litter invertebrates and heterotrophic process: 1997 revision. ES/ER/TM-126/R2. Oak Ridge National Laboratory, Environmental Sciences Division.

IRIS. 2005. Integrated Risk Information Systems. http://www.iris.com.

Kabata-Pendias, A., 2002. Trace Elements in Soils and Plants. CRC Press, Inc. Boca Raton, Florida.

ORNL, 1998, Empirical Models for the Uptake of Inorganic Chemicals from Soil by Plants, Bechtel Jacobs Company L.L.C., Oak Ridge, Tennessee, BJC/OR-133.

PRC, 1994. Draft Technical Memorandum: Development of Toxicity Reference Values, as Part of a Regional Approach for Conducting Ecological Risk Assessment at Naval Facilities in California. PRC Environmental Management, Inc. Prepared for the U.S. Department of Navy.

Sample, B.E., D.M. Opresko, and G.W Suter, II, 1996. Toxicological Benchmarks for Wildlife: 1996 Revision. ES/ER/TM-86/R3. Oak Ridge National Laboratory, Oak Ridge, Tennessee. 227 pp.

Sample, B.E., J. Beauchamp, R. Efroymson, G. W. Suter, II, and T.L. Ashwood, 1998a, Development and Validation of Bioaccumulation Models for Earthworms, ES/ER/TM-220. Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Sample, B.E., J. Beauchamp, R. Efroymson, and G.W. Suter, II, 1998b, Development and Validation of Bioaccumulation Models for Small Mammals, ES/ER/TM-219, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Turner, M.A., and R.H. Rust, 1971. Effects of Chromium on Growth and Mineral Nutrition of Soybeans. Soil Sci. Soc. Am. Proc., 35:755-58

COMPREHENSIVE RISK ASSESSMENT

LOWER WOMAN DRAINAGE EXPOSURE UNIT

VOLUME 11: ATTACHMENT 6

CRA Analytical Data Set